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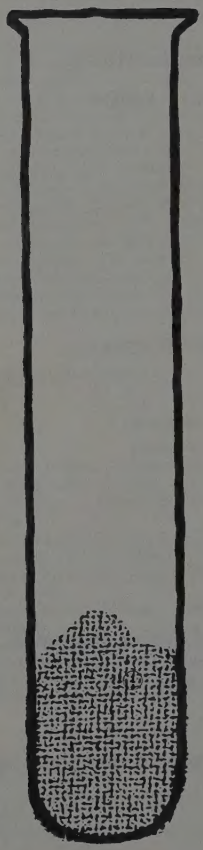

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AGRICULTURAL RESEARCH IN GREAT BRITAIN

On 1 April, 1956, the Agricultural Research Council Act came into force. This date is a milestone in the administration of agricultural research in this country, for under the Act the Agricultural Research Council was made directly responsible to Parliament for expenditure from public funds on research in agriculture in England and Wales. Formerly this function had been exercised by the Ministry of Agriculture, Fisheries and Food on the advice of the Council. The Act also provides that the Agricultural Research Council shall submit each year a report of the proceedings of the Council to the Committee of the Privy Council on Agricultural Research for presentation to Parliament. Reports for the years 1956-57 and 1957-58 have now appeared.*

Those who are interested in agricultural research will find a most readable account of its early development in the introduction to the first report. Old records show that the landowners and farmers often experimented with new systems of husbandry but agricultural research really had its beginning in the establishment by Sir John Lawes of the Rothamsted Experimental Station in 1843. It was here that some of the first controlled experiments in the use of fertilizers were carried out and, what is sometimes forgotten, the classic experiments which first demonstrated that carbohydrates supported fat production in pigs. In the meantime, other groups of individuals supported investigations in other fields of agricultural research and, as the volume of work expanded, grants-in-aid were sought from the State.

After a setback during the first world war, the tempo of research in the agricultural field increased. Small groups of investigators were merged into new research institutes governed by boards made up of representatives from the universities, agricultural societies and from the farming community. Financial aid came from benefactors and public subscription. These sources, however, were insufficient to meet the increasing cost of equipment and manpower necessary to tackle expanding programmes of research, the results of which were being successfully applied by enterprising farmers. Today the Agricultural Research Council, by grants-in-aid, supports many of the older research institutes to the extent of about 90 per cent of their financial expenditure, but these institutes are still administered by their independent governing bodies. Where it became evident that there were gaps in the service, the Government sponsored new institutes and these have been organized on similar lines, each with its own governing board. In all, there are now 22 agricultural research institutes with this type of constitution. In Scotland the research institutes receive the greater part of their funds from the Department of Agriculture for Scotland on the advice of the Agricultural Research Council.

Certain specialized and expensive fields of research were still not covered. These embraced such subjects as diseases in farm animals, and in order to meet this need a field station for research in animal disease was set up at Compton, in Berkshire, which is financed and administered directly by the Council. Three more institutes for research on animals have now been added to deal with other specialized aspects. In two further ways the Council supports research which offers hopes of benefit to agriculture. Firstly, it sets up small units, often closely associated with the universities, for special research under a distinguished leader who often holds the post of professor or reader in the university. Such units are usually disbanded when the leader retires and moves elsewhere. Secondly, the Council gives special grants to help university research projects; these are normally of quite limited duration. This, in outline, is the present pattern of administration in the field of agricultural research.

The reports include short accounts of the various research institutes and summaries of their current work. These reflect not only the wide compass of the research effort as a whole, but the complementary nature of the fundamental and the more applied approaches. The current techniques of the chemist and physicist, such as chromatography and the use of radio-isotopes, are all brought to bear in seeking solutions to the practical problems of the farm. In the field of physiology, fundamental investigations are being made of the role of endocrine substances in the control of milk secretion, and studies are being made on the effect of the implantation of small quantities of oestrogenic substances, such as hexoestrol, on the growth and development of fattening bullocks. Labelled hexoestrol has been used to trace the paths of excretion of this substance. Radio-isotopic techniques have also been used in an attempt to unravel the physiological conditions which control the uptake, penetration into, and transport of, phytotoxic compounds by different species of plants. This may afford an explanation of the varying susceptibility of different species to the growth-regulating type of herbicide.

Two new features of the Council's work are mentioned in the report for 1957-58. Until 1957, research covered by the Council tended to stop at the farm gate. It was obvious, however, that differences in breeding, feeding

* Report of the Agricultural Research Council for the year 1956–57 (Cmnd 432), 7s. Report for 1957–58 (Cmnd 750), 8s. London: H.M.S.O.

and general management of farm livestock can have marked effects on such things as carcase quality. Equally, methods of production can affect storage qualities in fruits and vegetables, and it seemed desirable that research on both production and the quality of the product should be the concern of one organization. For these reasons the Low Temperature Research Station, the Ditton Laboratory and the Pest Infestation Laboratory were transferred from the Department of Scientific and Industrial Research to the Agricultural Research Council. The other new feature is the assumption of responsibility for monitoring radioactive fall-out in soil, herbage, farm animals, milk and other foodstuffs. The Council will publish the results annually.

Although the summaries of research going on in the various research institutes and units will have appeal to those interested in specialized fields, the general reader will be more interested in knowing the present state of knowledge in certain subjects. It was for this reason that the Council in its second report has included a series of nine articles covering various aspects of agricultural research. These range from the introduction of electronic computers in research statistics to the application of modern genetic principles to livestock production, and serve a most useful purpose in bringing the reader abreast with recent research in these fields.

R. G. BASKETT

POSSIBLE NEW GRADE OF MEMBERSHIP AND CATEGORY OF AFFILIATION

STATEMENT BY THE COUNCIL

Last month (*J.*, 102) it was reported that the Council was exploring means whereby the Institute could appropriately take a more direct part in looking after the interests of those who go a considerable way in the study and practice of chemistry but do not proceed, or succeed in gaining admission, to graduate membership and thence to corporate membership of the Institute.

In reviewing the possibilities the Council, with the aid of its Professional Status Committee and Study Group on Qualifications, has given attention to current trends in the development of education and training at various levels, not only in chemistry and applied chemistry but also in other fields of science and technology. Special note has been taken of varying relationships between the requirements for admission to graduate or corporate membership of professional bodies and those for the award of Higher National Certificates and Diplomas in their respective fields. For such awards in Chemistry and in Applied Chemistry the Institute has a direct responsibility, jointly with the Ministry of Education, in England and Wales, and with the corresponding Departments in Scotland and Northern Ireland.

It has been agreed that it would be proper for the Institute to try to do something for all, or most, of those who get as far as a Higher National Certificate in Chemistry or in Applied Chemistry. It was decided that, in any event, special consideration should be given to those who, having a sound basis of general education, go on to, or reach by other routes, substantially higher and more broadly based standards of attainment than are represented by the minimum requirements for a pass in the H.N.C. As the Institute is exceptional in demanding the equivalent of a good honours degree in chemistry (or, with certain reservations, in biochemistry or applied chemistry) for admission to graduate membership, there may be special grounds for making separate provision for those who produce evidence of having reached a standard equivalent to what may be described as that of a good 'pass' degree in any of these fields. They may be regarded as qualified scientists (or technologists) though at a lower academic level than graduate or corporate members of the Institute. Thus, in Government reports, such as those on 'Scientific Manpower in Great Britain,' the term 'qualified scientist' is defined so as to include all who have obtained any type or class of university degree or equivalent qualification in science, in addition to graduate and corporate members of appropriate professional bodies; but it does not cover holders of Higher National Certificates or Diplomas as such.

It has been concluded that, for looking after the interests of those who had reached a good 'pass' degree standard and could thus claim to be classed as scientists (or technologists), the appropriate provision (*see* A below) would be a new grade of membership of the Institute. There may also be a case for doing something for those who did not get so far beyond satisfying the minimum requirements for the H.N.C., and, in that event, a possible additional provision (B) would be some kind of 'group' affiliated to the Institute.

The forms that these provisions might take and some of the questions their introduction would raise are indicated below as a basis for further discussion.

The Council wishes to make it quite clear that *no points of policy have yet been settled.* Nor will they be until there has been full opportunity for the important issues involved to be discussed at Local Section meetings,

at the forthcoming Conference of Liaison Officers and on other suitable occasions. An advance copy of this statement was sent to Hon. Secretaries of Local Sections so that they could consider it at their Conference on 8 April.

If the general reaction to provisions of either of the types outlined below seems to be favourable, it will be for the Council to consider drawing up specific proposals for submission to the general body of corporate members. It will be appreciated that, as the introduction of either type of provision would entail changes in By-laws, the adoption of such proposals will be dependent on appropriate resolutions being passed, by a two-thirds majority of votes cast in person or by proxy, at a Special General Meeting. There is no question of such a meeting being arranged before the autumn of this year.

OUTLINES OF POSSIBLE PROVISIONS

A. For the establishment of a new grade of membership of the Institute—Licentiateship.

The provisional title, Licentiateship, is not ideal but there is precedent among other bodies for its use in this way and no clearly better alternative has so far been suggested. Members of the grade would be known as 'Licentiates' and be entitled to use after their names the letters 'L.R.I.C.'

Applicants for admission to this grade would be required to show that they had satisfied (or been exempted from) the Institute's requirements as to general education and the study of physics and mathematics as ancillary subjects, and had reached a standard equivalent to that of a good 'pass' degree (*see* above) in chemistry or applied chemistry. A draft schedule of examples of qualifications that might be acceptable as evidence of this standard is appended (*see* p. 125). Further consideration is required as to how far a period of approved experience in practice should be a necessary additional condition for admission (*see* below).

Licentiates would pay an annual subscription and would be entitled to such publications, services and privileges as are available to Graduate Members.

No limit would be placed on the period of tenure of Licentiateship, which would thus be a third 'permanent' grade of membership (Student Membership and Graduate Membership are 'transitional' non-corporate grades). Nor is it envisaged that a Licentiate should be liable to removal or suspension from membership by the Council without his conduct having been subject to investigation by the Censors. In these respects Licentiateship would have the characteristics of a grade of 'corporate' membership.

On the other hand, it is not expected that Licentiates would be accorded the full voting rights at present enjoyed only by corporate members (Fellows and Associates), although consideration will need to be given to ways in which they could have some say in Institute affairs, or at least in matters of concern to members of their own grade. Also, classifying Licentiates as corporate members might seem inappropriate in view of their being at a lower academic level than Graduate Members, who are non-corporate. This inconsistency has now been reduced by according to Graduate Members the right to use the designatory letters 'Grad.R.I.C.' (*see* p. 144); it would be largely removed if a period of approved experience in practice were made a condition of admission to Licentiateship. These are among the questions that require further consideration.

Note: Hitherto the Council has been reluctant to support proposals for the establishment of a new permanent grade of membership at a level below that of the Associateship, 'largely because of the confusion that might arise as to relative standards of attainment, especially if membership of the new grade were to be represented by designatory letters' (cf. *J.*, 1957, 456). Although this danger still exists, it is believed that it has lessened, as the standards represented by existing grades have become more widely recognized. Indeed, it may be that the establishment of a Licentiateship grade might now serve to emphasize the very high standards of the existing grades and thus to increase rather than diminish the esteem in which they are held.

B. For the formation of a Registered Chemical Assistants Group, affiliated to the Institute.

Applicants for registration as members of the Group would be required to show that they had obtained at least a Higher National Certificate in Chemistry (or in Applied Chemistry) or an approved equivalent qualification, and had obtained appropriate experience in the practice of chemistry during (or after) their training for the award.

Members of the Group would not be in any grade of membership of the Institute, nor would they be entitled to the use of any designatory letters that might imply such membership. They would be required to pay an annual registration fee, and in return would be entitled to receive certain Institute publications (at least the *Journal*) and to enjoy such other Institute facilities as may be prescribed; these might include special services to the Group as such. Although they would not be members of Local Sections, they might be invited to certain meetings, and there is the possibility of separate or joint Group meetings being arranged in suitable localities.

No limit would be placed on the period of tenure of membership of the Group.

Note: The formation of an affiliated Group is put forward as an additional possibility—and not as an alternative to the suggested establishment of a Licentiateship grade. It is by no means clear if there is a real

need for a Group of this kind or if the facilities that could be provided for its members would be sufficiently attractive. Thus, it is recognized that, in so far as increasing numbers of young people now have a good educational background before they enter upon National Certificate courses, more of them should become eligible for Student Membership at Ordinary National Certificate stage. Although this is a transitional grade, it does represent membership of the Institute and may well be preferred by those who hope to go beyond H.N.C. to at least Licentiateship. The question is whether those who are not eligible for Student Membership (or do not succeed in going beyond that grade within the prescribed period) would be interested in membership of a Group of the kind envisaged.

IMPLICATIONS

In recent years the numbers of Higher National Certificates in Chemistry awarded have averaged over 900 per annum, whereas less than 50 per annum have been granted in Applied Chemistry. Most of those who obtained either of these awards would become eligible forthwith for membership of the suggested Registered Chemical Assistants Group if it were established. For many of these—so far, perhaps the majority—the H.N.C. represents the ceiling of their academic attainments, and they would be able to stay as members of the Group.

On present showing, about 20 per cent of those who obtain the H.N.C. in Chemistry secure exemption from or subsequently pass Part I of the Graduate Membership examination, and it is to be expected that more than half of these will eventually pass Part II. It is noteworthy, however, that larger numbers of students now coming into National Certificate courses have already several G.C.E. 'O' level passes, and even 'A' level passes in subjects relevant to the course. Also, increasing numbers of students take physics and mathematics at Ordinary National Certificate level, either as endorsements or as part of the O.N.C. course. It is to be hoped, therefore, that in future a larger proportion of those who obtain the H.N.C. will be able to satisfy the Institute's requirements as to general education and ancillary physics and mathematics, and thus be in a position to enter for the Part I examination if they do not secure exemption from it. It may be that this proportion would become much greater if there were the incentive of the Licentiateship, as a permanent grade of membership of the Institute at a not too discouragingly higher academic level, especially if the gap could be bridged, at least partly, by courses of an applied type leading, for example, to H.N.C. endorsements in such 'technological' subjects as radiochemistry, modern analytical methods or spectroscopy and colorimetry.

Some who obtain the H.N.C. in Applied Chemistry go on to qualify for grades of membership in professional technological institutions, such as the Society of Dyers and Colourists, the Institution of the Rubber Industry and the Plastics Institute. This tendency is likely to grow and is to be encouraged.

Higher National Diplomas in Chemistry and in Applied Chemistry have only recently been introduced but it is expected that the numbers of those who obtain these qualifications will grow rapidly. Only full-time or sandwich courses lead to these awards, whereas only part-time students are eligible for National Certificates. The time available for study in an H.N.D. course is substantially greater than in those for the H.N.C. The standard reached in *chemistry* for the H.N.D. in Chemistry is at least as high as for the H.N.C. (at about 'pass' degree level) and should be more broadly based; provision is also made for taking several ancillary subjects and for liberal studies. It is expected therefore that most of those who obtain the H.N.D. would be in a position to qualify for the Licentiateship.

Every year there are several hundreds who obtain university degrees which have chemistry as the main or a principal subject, but which are not of a type or in a class to provide exemption from the whole of the Graduate Membership examination or even, in some instances, eligibility to enter for Part II without further systematic study. Most of these would be, or could readily become, acceptable as Licentiates. So also would those who obtain the Diploma in Technology (in Applied Chemistry, Chemical Technology or Industrial Chemistry) but are not able to secure direct admission to Graduate Membership. This is a relatively new type of award, based on full-time or sandwich courses of honours degree standard, but the numbers taking it are expected to increase rapidly.

From these various streams, including that leading directly to the Institute's own examinations, there would thus emerge large and growing numbers of acceptable candidates for the Licentiateship. In addition, provision might be made for admitting to the Licentiateship holders of the H.N.C. (or the H.N.D.) who had not fully satisfied all the additional requirements but had held a position of special responsibility as a chemist over a considerable number of years, and were well supported by referees. Such candidates might be required to submit to a special examination such as is now imposed on applicants for admission to the Associateship under Regulation G4. Indeed, Licentiateship might be a more appropriate grade for many of those who have recently been seeking unsuccessfully to become Associates under this Regulation.

Although Licentiateship would be a 'permanent' grade of membership, it is to be expected that some Licentiates would go further by taking the Part II examination. It is probable that more would go on to qualify for Graduate Membership if this could be done through courses on the applied side, leading to examinations comparable with those for Diplomas in Technology or University Honours Degrees in Applied

Chemistry. It would be helpful, in this connection, if arrangements could be made for admission to the later stages of an appropriate Dip.Tech. course, or for recognition by the Institute of specially designed courses leading to alternative types of Part II examination based on them. It would need to be ensured, however, that no such candidate could obtain admission to Graduate Membership without having complied with the requirements in respect of a third ancillary subject and the total period of systematic training, or without having taken inorganic, organic and physical chemistry to at least pass degree standard in externally assessed examinations or made good any deficiency. These possibilities need further consideration.

Licentiates who go on to qualify for admission to Graduate Membership could transfer to that grade forthwith but, as this would entail moving from a permanent to a transitional grade, they might prefer to remain Licentiates until they had obtained the further experience required for admission to the Associateship.

APPENDIX

DRAFT SCHEDULE OF EXAMPLES OF QUALIFICATIONS

that might be acceptable as satisfying the academic requirements for admission to Licentiateship

Any *one* of the following sets of qualifications and conditions:

(1) Qualified for entry to and passed (or secured exemption from) Part I of the Graduate Membership examination, subject to evidence of having pursued an appropriate course of practical work and having passed an approved practical examination (an internal college examination might be approved for this purpose to cover candidates who had not satisfied the practical requirements for H.N.C. in Chemistry).

(2) Obtained the H.N.C. in Chemistry (or, subject to certain conditions, in Applied Chemistry) and passed an externally assessed examination in an approved field or fields of pure or applied chemistry or related technology, following the satisfactory completion of a post-H.N.C. course extending over one or two years of part-time study (the period might depend on the candidate's performance in the H.N.C. examination). The candidate must also have complied with the Institute's normal requirements as to general education and the study of physics and mathematics as ancillary subjects.

(3) Obtained the H.N.D. in Chemistry (or, subject to certain conditions, in Applied Chemistry). The candidate must also have complied with the Institute's normal requirements as to general education and the study of physics and mathematics as ancillary subjects.

(4) Obtained the Diploma in Technology in Applied Chemistry, Chemical Technology or Industrial Chemistry, provided that if the course was not approved for Part II exemption purposes, the candidate will be required to make good a deficiency in any of the main branches of chemistry by taking the appropriate paper or papers in the Part I examination.

(5) Obtained a Degree in Science of a British University with chemistry as the main or a principal subject, provided that a candidate who had obtained an 'ordinary' pass degree on a course of less than 3 years' full-time study will be required to furnish evidence that he has studied the three main branches of chemistry to at least 'pass' degree level and has received appropriate practical training, or to make good any deficiency.

(6) Obtained a Degree of a British university in Biochemistry, Applied Chemistry or Pharmacy, provided that if the course was not approved for Part II exemption purposes, the candidate will be required to furnish evidence that he has studied the three main branches of chemistry to at least 'pass' degree level and has received appropriate practical training, or to make good any deficiency.

RATIO ATQUE USUS

'The history of philosophy [science] enjoys, in some measure, the advantages both of civil and natural history, whereby it is relieved from what is most tedious and disgusting in both. Philosophy exhibits the powers of nature, discovered and directed by human art. It has, therefore, in some measure, the boundless variety with the amazing uniformity of the one, and likewise everything that is pleasing and interesting in the other. . . .

It is here that we see the human understanding to its greatest advantage, grasping at the noblest objects, and increasing its own powers, by acquiring to itself the powers of nature, and directing them to the accomplishment of its own views; whereby the security and happiness of mankind are daily improved. Human abilities are chiefly conspicuous in adapting means to ends, and in deducing one thing from another by the method of analogy. . . .'

J. Priestley, Preface to the First Edition of *The History and Present State of Electricity*, 1767.

FIFTY YEARS AGO

'I am not now criticizing the methods and ideals of the Schools of Chemistry in our Universities, but the point I wish to emphasize is that these ideals and the methods with which they are associated are neither calculated nor intended to produce men who are professionally equipped. . . . For what other calling in life is it considered sufficient that a young man should pass three or four of the most receptive years of his life in an intellectual atmosphere and amidst academic ideals into which few if any gleams of the work-a-day side of life can penetrate? Yet, if we are to accept the dicta of some of our academic teachers, this is all that is required by the chemist before he enters practical life.

'Chemistry as a factor in the life of the nation is still in its infancy; it is for the Institute to cherish and develop this infant into a strong and vigorous manhood. While others criticize and theorize let us get to work and make our influence felt.'

Dr (later Sir) George Beilby, Presidential Address, 1910.

CHEMISTRY, INDUSTRY AND SOCIETY

By E. LeQ. HERBERT, B.SC., F.H.-W.C., M.I.CHEM.E., F.INST.PET., F.INST.F., F.R.I.C.*

The Institute of Chemistry (now the Royal Institute of Chemistry) was founded in 1877 to provide a means of recognizing those 'who have been properly trained and proved to be competent to practise chemistry as a profession'. These words were wisely chosen and I feel that there is no need to change them today. Endless experiment, frequent major discoveries, thousands of published papers have developed chemistry into a tree of knowledge greatly beyond the grasp of any one person, however devoted to the study; and there is a sense in which, say, the physical chemist, moving along one great limb of the tree, soon loses sight of his fellow, perhaps an organic chemist, who has chosen another of the branches. Even on one branch chemistry is practised in different ways, and each industry needs it in its own way. One physical chemist, for example, may spend all his life in the metallurgical industry; another may give all his attention to plastics. The result may well be that they finish up by speaking, as it were, in different dialects. But whenever and wherever chemistry is practised this specialization is, I am afraid, inevitable. In no sense, however, does it alter the objects of the Institute: indeed it emphasizes them and stresses the need for such a body. Proper training and competence to practise chemistry as a profession still stand as the criterion.

One word more about this specialization, which (as I say) is inevitable. It should not mean an utterly exclusive devotion to one small sphere—a life that has no existence outside, say, the laboratory. A man cannot hide, under the cloak of specialist, from his duties as a human being—that is, if he really is to practise chemistry as a profession and be properly one of our number. Specialization must be his particular usefulness, his drawn sword and not his shield. What the world still seeks from us is, I suggest, 'either a good man with a first-class knowledge of chemistry or a first-class man with a good knowledge of chemistry'.

In industry today directors are often young men, and that is to the benefit of all concerned. It is not yet the fashion, however, to choose a young man as President of a learned society or professional body. So it is that I have a good many working years to look back over, and as they were all spent in a single industry it is natural (if not inevitable) that I should draw the substance of my presidential address from that industry, and from the special applications of chemistry which it demands.

THE CHEMIST AND SOCIETY

My industry—the petroleum industry—is so bound up with modern civilization that it is difficult to express the relationship between the two. We frequently speak of 'the demands of a technical civilization', but quite often these demands spring from ideas or possibilities that were revealed in the first place by the very industries that subsequently must respond to them. Perhaps the nearest we can get to the right expression is 'useless each without the other', which is how Longfellow epitomized the relationship between man and woman.

But, similes apart, anyone can see for himself that the petroleum industry, wherever it goes, has a profound effect on society and that it cannot stand still. New needs are always confronting the world and new means must be found to meet them.

In this industry chemists have always ranked among the leaders, and there must be few careers, if any, open to the chemist of today that bring him so soon face to face with the theme of this address—Industry and Society. Essential in its management (as with other great industries) is an understanding of world and local politics, of the balance of international trade, of economics and of many other things that might seem at first sight outside the province of the chemist as a professional man. Within the industry he is a fellow-worker; in society he must show himself as something more: as a man—a 'good' man in the best and widest sense.

The petroleum refining industry is a young one. Although it celebrated a centenary last year, most of its major developments have been within living memory—certainly since the date at which our Institute was founded. In these advances you will always find the chemist, working in harmony with men of other disciplines—with physicists, with engineers—chemical, civil, mechanical and electrical—and with others. Our methods and the ways in which we have solved our problems have been, not traditional, but technological, and for this reason the chemist entering the industry becomes heir to a handsome legacy of accumulated wisdom and knowledge. Let us now take a look at the ways in which he can apply it; and to do this I would like to consider the planning, the development and the building of a new refinery.

WHAT A REFINERY DOES

The decision to site an oil refinery in a particular place is primarily a commercial one; but before it is reached, a number of economic and even political factors must be taken into account. I shall be considering these influences in more detail presently insofar as they concern the chemist and the engineer; but for the moment let us suppose that the decision *has* been taken

* Presidential Address, delivered in the David Keir Building, Queen's University, Belfast, on 6 April.

to build. What then do we say to the layman who asks what practical benefit this refinery will bring to the community? We would, I think, answer somewhat like this:

'Instead of bringing into your country refined products such as petrol and diesel oil, we shall import crude oil and make the products locally to meet the market demand; chemicals from petroleum may also come into the picture. This calls for a high degree of technical skill if the various products are to be produced economically in the right quantities. Crude oil is more generally available than all the products, and there are several different places from which we can get it.

'Looking at the project more broadly, you can see the capital value of the refinery, and its ability to provide employment for skilled workers, as an increase in the wealth of your locality. To begin with, the refinery will probably be a simple one, making petrol, diesel oil, gas oil, fuel oil and probably liquefied petroleum gases, but it will be flexible and readily adaptable so that other petroleum products can be made when a need for them is established.'

If, on the other hand, it were a chemist who asked what happens in a refinery, my short answer would be in somewhat different language. One would say something like this:

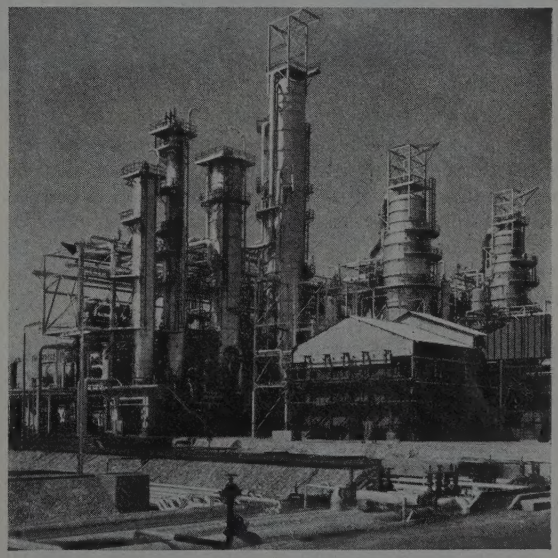
'Crude oil is drained free of water and distilled on continuous units into gas, several liquid fractions—perhaps as many as eight—each with a boiling range of about 50°C, and a residue of heavy fuel oil. The 90°C—180°C fractions are submitted to pyrolysis in the presence of hydrogen over a catalyst to convert naphthenes and paraffins to aromatics. Fractions boiling above 180°C are collected and blended for sale as diesel oils and gas oils. The part allocated to some of the fractions for diesel oil will be hydrogenated over a cobalt–molybdena catalyst to remove any compounds of sulphur and nitrogen. Some of the heavy fuel oil will be vacuum-distilled for production of bitumen of various grades.'

It cannot have taken much more than a hundred words to say that, but implicit in them is a hundred years of experience in the application of chemical and physical knowledge. Let us just consider what is really involved and how the processes have been developed.

It is easy enough to say, as I did at the beginning, that crude oil is drained free of water. In fact, however, the reluctance of water to separate from some crude oils has always been something of a mystery and still is a major problem. The oilfield often produces oil and water simultaneously—connate water, as it is called. If the oil is very viscous, say about 500 centistokes, and has a specific gravity nearly equal to that of water, one can understand why settlement of the water is hindered: but it is strange that a crude oil of specific gravity, say, 0·87 and of viscosity not much above that of water should resist the settling of large drops—sometimes even massive portions of water, particularly when the overall water content of the oil is low.

Colloid chemistry and the physics of electric fields are often successfully applied so that the water settles within the economic residence time. With some crude oils, however, the water gets through to the distilling units to be a thorough nuisance. It may not be finally separated and expelled until after evaporation, which consumes ten times the heat needed to evaporate oil, and subsequent condensation with the light gasoline produced, whereby it becomes a medium for all kinds of electrolytic corrosion. Still with us, then, is a hundred-year-old problem.

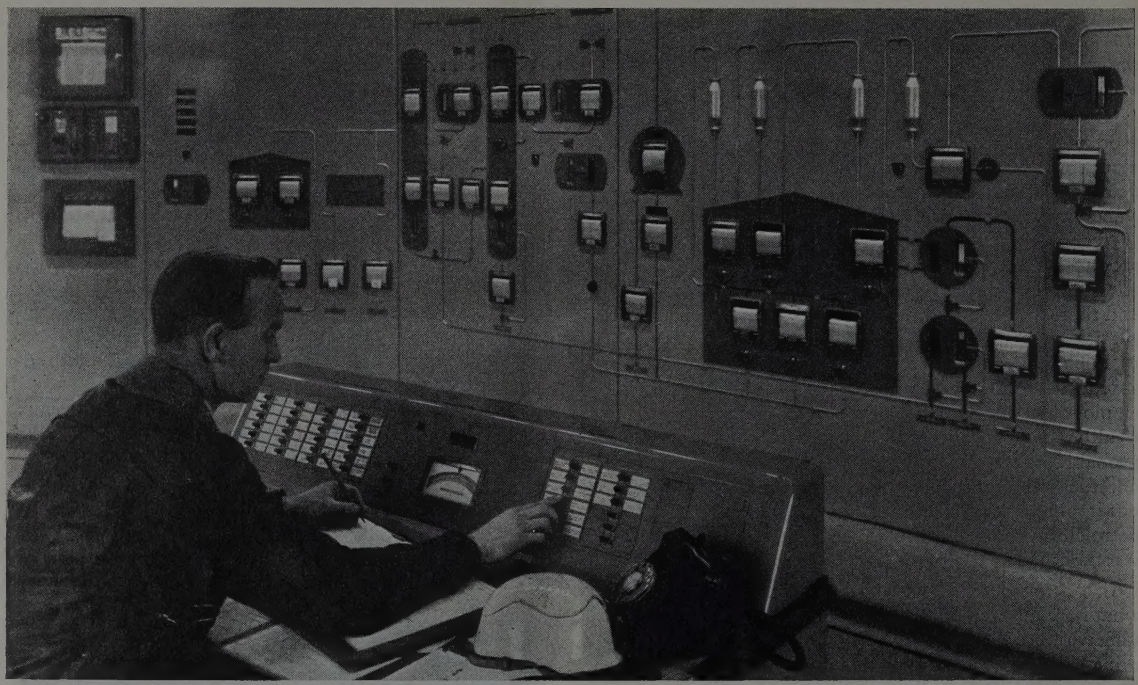
The modern form of distilling unit for crude oil really began with the invention about 50 years ago of the pipestill, which made possible distillation in continuous units without an inherent limit on the quantity distilled per unit per day. Modern units are often built in the range 10,000–20,000 tons of crude oil per day. In a pipestill the oil is pumped through continuous coils of pipe suspended in the combustion chamber of a furnace



A modern crude oil Distillation Unit (Cardon, Venezuela)

and the temperature rise is very rapid. The fractionation equipment is not peculiar to the petroleum industry. It was taken over from designs used to distil alcohol or coal tar, though special types of fractionating column and tray have been evolved which are particularly successful with petroleum.

The design of these columns depends on accurate knowledge of vapour–liquid relationships of hydrocarbons and on knowing broadly the distribution of



A Control Room in a Platforming Unit (Stanlow)

hydrocarbons in the crude oil, matters which are basically physical and analytical chemistry. In judging the performance of these units the first information consists of pressures, temperatures, levels and flows, read or recorded (and of course frequently controlled) by instruments, and the analyses of the incoming, outgoing and some intermediate streams.

Catalytic reforming or pyrolysis of light oils, practised so as to convert naphthenes and paraffins to aromatics by dehydrogenation and cyclization, is a process about twelve years old and is just applied chemistry, though very dependent on the engineer and the metallurgist. Five molecules of hydrogen to one of the light hydrocarbon fraction, an operating temperature of say 530°C and a pressure of up to 800 lb/in², are conditions calling for special steels and expert knowledge. Distillation of heavy oil under vacuum in large units is a special problem in the industry because beyond a certain temperature, say 400°C, decomposition of the oil is so rapid that only a few seconds of time can be allowed. The degree of vacuum is set by this consideration, and the plant must be designed so that its hold-up of hot material is very small. This is perhaps an instance where the special service of the chemist is to set the problem and to decide how well other people with other skills have provided the solution. I suppose the practice is about 30 years old.

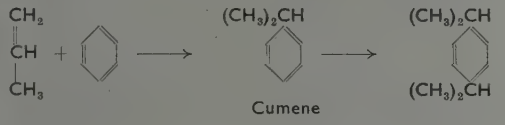
In my 100-word answer to the chemist's question, by the way, I made no mention of various treating processes where the product streams are washed with caustic soda or other chemical solutions. These processes are as old as petroleum refining, though from time to time they have been improved.

CHEMICALS FROM PETROLEUM

I think there is no doubt that one of the most interesting and far-reaching of the more recent developments has been the birth and growth of the petroleum chemicals industry. This industry came into being because many common industrial organic chemicals (initially acetone and the higher alcohols) could be made more cheaply from refinery-produced propylene and butylene. For this reason plants to make these products were placed adjacent to refineries or within them. By now, of course, it is a chemical industry—a major one, too—in its own right, though it is still a good customer of the petroleum industry for many of its feedstocks. A strong family likeness, however, persists between the two industries. The products are still being made, for example, very much in the way a petroleum refiner would make them, and the plant has the same rather neat arrangement and general lay-out developed by the oil-refining industry (cf. photographs on p. 129); both make advanced use of automatic control and of

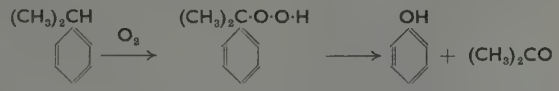
many devices that are the trusted servants of the designer of petroleum processes. It is easy to see how this arises, and I will give only one example to illustrate the point.

The petroleum refiner has long used alkylation of isobutane with butylene to make iso-octane, which is particularly useful in aviation gasoline. This has been done for many years, butylene being run into a circulating emulsion of isobutane and sulphuric or hydrofluoric acid, cooled to take away the heat of reaction. The iso-octane made in this way is used exclusively as a fuel. But if, instead of isobutane and butylene, we use benzene and propylene, then we make cumene and some di-isopropyl benzene :—



Cumene

Cumene can be used in aviation gasoline as it has very superior performance in supercharged aviation engines, but it has a rather high boiling point for modern specifications (150°C compared with 100–115°C for the iso-octanes). Its chief application is as an intermediate; for instance it will form a peroxide which in dilute mineral acid breaks down into phenol and acetone.



Di-isopropyl benzene has virtually no application as a special fuel and is used entirely as an intermediate for further synthesis. For instance, it may be oxidized to terephthalic acid, one of the base materials for making the well-known synthetic fibre, Terylene.

Now operation on propylene and benzene is the same as on butylene and iso-butane, except for a higher plant pressure and perhaps one extra column and some adjustment of flows, temperatures and acid strength. But it would be hard even for the expert visitor to tell from its *outward* appearance whether the plant was making iso-octane, the typical super-fuel, or chiefly di-isopropyl benzene, the typical chemical intermediate, or cumene, usable as either type. The other way of making cumene, by vapour-phase reaction over phosphoric acid in kieselguhr, is also a petroleum process in origin, having been first used for polymerization of butylene to iso-octene. I mention these aspects to show how nearly petroleum refining can approach the heavy organic chemicals industry, where it would be at once conceded that the chemist holds sway.

WHAT MAKES A MANAGER?

I suggested earlier in this address that within industry the chemist is a fellow-worker and that in society he must show himself as something more. That is part of my theme that can well be illustrated by looking at the human aspects of an oil refinery.

First of all, then, a rapid glance at what official documents sometimes call the 'place of work'.

A typical modern fully integrated refinery, with a substantial chemical plant, such as is shown on p. 132, will have cost about £80 million. It employs about 4,500 people. Of these perhaps 150 are qualified technical staff, and some 50 or so would be in management and executive positions. In other words, of all the graduates employed, at least one in three is directing and regulating the performance of others. This does not mean, though, that they have ceased to use chemistry or physics or engineering or whatever science or technology they qualified in. The manager in charge of a particular plant—or maybe several similar plants—is the man who decides on proper evidence that, say, in his process the heat of reaction has increased and the catalyst must

An Alkylation Plant for manufacturing high-octane gasoline (Cardon, Venezuela)

A typical Petroleum Chemical Plant (Stanlow)

receive more cooling, and that this is best done by adjustment of a cooling jacket pressure. It is he who supervises the operation and sees that it is done safely and understood by the operator who turns the hand wheels. He may afterwards have to convince his superiors that he did what was best and then sit down to write to head office an account of the incident, lucid so that an informed reader at great distance can understand it.

This plant manager may at length attain to the highest positions in the directorate where ability to appreciate technical considerations, and to be affected by technical knowledge and argument as well as by economic and plain business facts, is specially needed. But here excellence merely in technical knowledge is not enough; the aspirant will be judged too by the decisions he has made and how, as an executive, he explains them to his subordinates; in other words, by abilities that form no part of what is needed for a science or technology degree.

Nevertheless, the scientific discipline (of which a degree or equivalent qualification is the hall-mark) is a first essential, and the universities fully recognize that if a man deploys his abilities too much in those critical years, he may well fail of technical excellence. But the words 'too much' are important; some universities, indeed, insist that the science student should come to them with at least 'one other thing' not directly related to his chosen study—I do not mean knowledge of, say, German or Russian, which he could apply almost immediately, but something like Latin or Hebrew or Music or even perhaps the ability to write verse. This is a policy I firmly believe in, provided they keep on with this 'one other thing'. It helps to broaden their field of judgment and, in my view, makes them abler than others to take on more 'other things', which, as I have said, they must do if they are to reach the higher levels of management in their profession. Here I mean such intrinsically non-technical considerations as understanding human nature, recognizing justice and the art of getting on with people of all races.

I would not, however, put any new burden on the universities; industry must take over this broadening process by selecting, planning and helping the young man's career, and so develop this vital relationship between industry and society. By such means are the managers of the future produced. The promising recruit will, in a large sense, mould himself by what he sees; but it is up to the industry to ensure that, as his career develops, the view offered him is wide enough.

Having reached management, what is the chemist likely to be called upon to direct? He may be managing mainly his fellow chemists, as a *research* manager directing the research projects, receiving the reports of each team and discussing the further effort. He will have to make the first decision on how far the effort should go. Or he may manage a *development* group where the processes are taken from the laboratory and pilot-plant stage and applied to full-scale operation. Here the planning must be considered economically, in relation to the ground and type of labour available, and a multitude of other local factors and circumstances.

Or again, he may manage a *planning* division, where use of every unit of plant is forecast into a harmonious effort synchronized with the estimated demand, so that what is needed is made most economically. Yet again, he may manage a *refinery*. Here, most of his time will be taken up with day-to-day problems, enquiries and conferences, all of which are necessary to keep the huge units continuously in operation and well maintained. He must know his chemistry if chemist is what he be; it is what he is doing. But he is doing it *through people*, and his ability is measured now by the strength of his industrial relations and relationship with his staff. Apart from them, there is now no outlet for his technical knowledge.

THE REFINERY AND THE COMMUNITY

I have said enough, I think, about the community within the petroleum industry for you to be able to see a refinery, not so much as a vast piece of inanimate complexity, but as an expression of a century of research, of experiment and achievement by men, many of them chemists, intent on meeting the needs of the modern world. Now perhaps you will allow me to look outward from the refinery into the larger community of which it is a member. So far, I have been considering it as built and in operation, but behind this must have lain months or even years of study and negotiation to arrive at the coincidence of policies, between government on the one hand and the petroleum company on the other, that determined where the refinery should be and the balance of products required to meet the market demand.

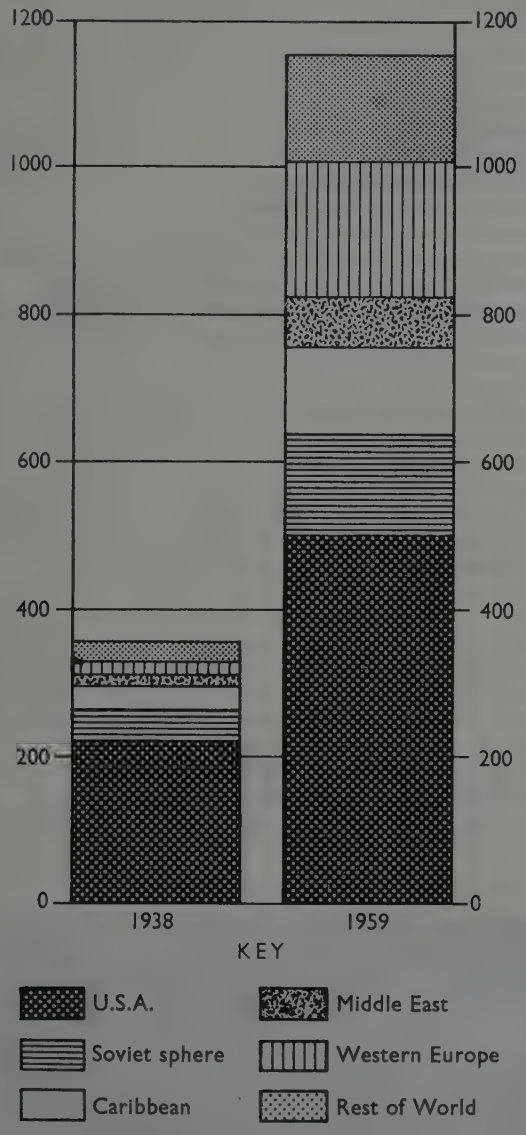
First as to location. A refinery may be called for in a remote region such as desert, where there are no other industries; then suddenly wealth is created and modern life, with all its complexities, springs into being. On the other hand, it may be needed in a large industrial area; then it may cause a readjustment in the old equilibria (social, financial and economic) of the district.

Before World War II, most refineries outside the U.S.A. were situated at or near oilfields, which in general were in remote and undeveloped country. In the consuming areas, such refineries as existed were usually small and manufactured speciality products, such as bitumens and lubricating oils. The U.S.A. was exceptional, because crude oil as well as the market for refined products were both found in the same country.

Since the war there has been a startling change. New refineries have sprung up all over the world, generally in consuming rather than in producing areas; take for example the tremendous and rapid development of the oil-refining business in the United Kingdom,

Western Europe and Australia. In bringing about this change many different factors have played their part.

There was the acute shortage of refining capacity that was felt immediately after the end of the war, and the need to build quickly where raw materials and skilled



World Crude Oil Refining Capacity
(million metric tons per annum)

labour were most readily available, that is, in the industrialized countries of Europe. Then there was the shock of Abadan in 1951, which underlined the vulnerability of the large all-purpose refinery situated far from home and relying on one source of crude oil only. There was the growth in size and speed of tankers, making it cheaper to transport very large quantities of crude oil on a steady course from oilfield to refinery—what the tanker captains call the 'milk run'—rather than mixed cargoes of products to a changing variety of coastal installations. More recently, too, there have been the insistent demands of a growing number of governments that a refinery should be built in their own country, almost irrespective of the precise balance of economic advantage it would bring.

All these influences have tended in the same direction, that is towards the building of refineries in consumer countries, and I suggest that this may bring advantages to all concerned. There will be greater diversity and flexibility, so important in ensuring long-term security of supplies, besides the economies of scale inherent in today's methods of crude oil transport. There may be other advantages, too, for a consumer country. The refinery itself will employ local people, although not very many because modern simple refineries are not, on the whole, large employers of labour. However, the presence of a refinery often encourages the development of other industries, which may well employ far more people than the refinery itself.

If this happens, then a mutually satisfying situation will exist. There will be less unemployment, and an opportunity to raise the standard of living of all. Those countries with the highest energy consumption *per capita* enjoy the highest standard of living, although I admit there is no simple relationship between the two. These advantages are greatest in countries which have virtually no indigenous fuels, but in part at least they are available to almost all countries.

I must stress that the construction of a refinery is an expensive business, and a new one is usually built to the simplest and most compact design compatible with the basic needs of the country it will serve. However, as the years go by it will usually be possible to enlarge and extend it by new construction, if pressing enough needs arise for new oil products and petroleum chemicals.

I will not burden you with the thousand and one things and several distinct stages that have to be gone through before a precise site is selected, the refinery is built and finally comes 'on stream'. I am concerned here only with the community relationship and will content myself with making two points.

My first is that, even if one has to build a refinery many miles distant from any inhabited areas (and this may be necessary on account of marine facilities and other geographical factors) this splendid isolation does not continue for long. Other industries tend to grow up round the site and in only a few years the area may become quite heavily populated. With this experience behind us, much effort is made to design our refineries on a 'good neighbour' basis so that their presence and behaviour will result in the minimum of inconvenience to other people.

My second point relates specifically to skills that one can, as it were, implant in a country. For the running of the refinery we will, so far as is possible, rely upon local talent. The jobs themselves, however, may as yet be quite unknown there; so, in advance of the refinery's construction, personnel will be selected and sent elsewhere to learn on existing plant what will be required of them. On return home, it is they, backed up by a team of experts, who will be responsible for getting the refinery started up and in full production. As they gain experience, more room will be made for their fellow countrymen, as the 'imported' experts gradually move out.

Within this whole picture, then, we see the chemist concerning himself first with a theoretical scheme that will provide a country with the refined products it needs, negotiating with a myriad of interests, turning the scheme into a practicable design, assisting in its construction, training locally recruited staff, bringing the plant into full continuous operation and then moving on to where his experience is in similar demand. I do not need to stress the responsibility he carries, but this short catalogue of requirements does illustrate, I think, what I had in mind a moment ago when I referred to the 'other things' the industrial chemist needs in his make-up. Today business is not merely manufacturing, buying and selling. It is analysing cause, deducing effect, using foresight, exercising judgment, taking responsibility—in short putting to use imagination and those other of the higher faculties which are awakened in a scientist broadly and liberally educated.

My picture of the refinery overseas ended with the foreign experts departing to apply their chemistry and their other talents elsewhere. I suggest, though, that they should have left behind them something of wider significance than an efficiently running refinery turning out products to specification. This brings me to the last thread of my theme which has been drawn designedly from the constitution and objects of our Institute: 'The ethical standards of the profession.'

First, these men brought into the locality something new by way of ideas, production potential and people. The impact of these varies, of course, with the state of development of the place where the refinery is sited. I am of the generation that remembers vividly the creation of these 20th-century wonders in what were almost jungle or desert areas that, apart from the lack of marine facilities, might have been on Robinson Crusoe's island. At the other end of the scale I have shared the pride and excitement of the industry's blossoming in post-war Britain and in Western Europe. But no matter where it arrives, this prodigy of chemistry and chemical engineering—if I may so describe a modern refinery—calls for the skills and effort appropriate to that one place and time; and it is my experience that, where there are people, there is normally potential for the development of these skills, however strange western technology may at first sight have seemed.

I could give you examples from Asia, from Africa or from Latin America, but the refinery built at Stanlow in the marshland no more than 15 miles from Liverpool, a view of which is given below, is a good illustration of what I mean.

Here was British labour, skilled in such engineering enterprises because it had had opportunity of similar work before. In remoter parts, the chemist and the engineer have no such previous experience to build upon and it is incumbent upon them to train and educate their own labour force—some for the period of construction only and a smaller proportion to remain on the site. In doing this they are making a direct contribution to the basic capital of the country, for capital consists no less of skills and know-how than of hard cash. It is capital of both these kinds that the newly emergent countries so urgently need at the present time. Nor, I think, does the oil refinery's potential contribution to the intellectual capital of the country stop here; we must

General View of Stanlow Refinery

consider also the stimulus it offers to the local development of skills in a number of ancillary activities—from medical services to light industries—and particularly the effect of the immigrant graduate staff.

Here, I suggest, an old pattern is repeating itself: masters of special technologies migrating (in not very large numbers) and settling in communities where their skills were new and welcome; ceramic artists from Minoan Crete crossing to cities in the Aegean; Flemish weavers to the eastern British seaboard; and the Huguenots, with their own special techniques, putting new life into the linen industry here in Northern Ireland. Let us remember, though, that as well as their skills from which whole industries developed, such immigrants also brought in their own ethics and a good deal of their own inherited culture.

So, too, it is with the graduate chemist or engineer and their colleagues when they carry a western culture into less developed countries. Urgent and ethical problems may arise and we cannot leave them, with their wide implications, to solve themselves. The lands I think of are emergent, not dormant, and it is very much their decision to accept or reject what industry offers from abroad. I suggest to you therefore that a great responsibility lies upon the scientist, the technologist or any other professional man when it comes to a consideration of how western technologies can best assist these emergent or resurgent countries in achieving their national aims. Here above all, the relation of professional ethics to industry and society must be acknowledged and used for good.

And so I would conclude with a brief word about the attitude of direction and higher management in modern industry to professional chemists. I think it is simply this: Industry, every section of it, needs them; some from every branch of the profession. We hope that in addition to proven competence to practise chemistry they will also have initiative and drive, and will possess at least some of the 'other things' of which I have spoken.

On the part of direction and management, there must be a willingness to discuss and to advance and a marked sympathy towards new ideas. In a sense, we are waiting to learn what the future can produce, knowing how greatly individual technologies can benefit from someone with a new point of view putting the right idea forward in the right place at the right time. Speaking from some thirty-seven years' experience in the oil-refining industry, I can truthfully say that such patience has brought no disappointment in the past. I am equally certain that with the standard of competence ensured by the training and the 'other things' gained in our universities and also more and more nowadays in the colleges of technology, and by the standard the Institute sets for its own graduate membership, we can have every confidence in the future.

THE NEW UNIT OF ATOMIC WEIGHT $^{12}C = 12$

By D. H. WHIFFEN, M.A.*
National Physical Laboratory, Teddington

The Council of the International Union of Pure and Applied Chemistry is resolved that the Union tentatively adopt a new scale of atomic weights based on the whole number 12 as the atomic weight of the dominant natural isotope of carbon-12, in replacement of the currently used scale based on the whole number 16 as the atomic weight of natural oxygen.

The statement quoted above appeared in the *Proceedings of the Chemical Society* for October, 1959, and many readers must be curious to know in what way they will be affected by the change. The numerical adjustment is so small (43 p.p.m.) that the majority of research chemists may remain oblivious to the change without error, although the few who occasionally use the physical scale of atomic weights must remember to use an appropriately modified value of Avogadro's number in connection with the new mass values. Although the numerical consequences of the change are so slight, it is fundamental in character. Those who teach chemistry must note the change as they are responsible for disseminating the correct definition of the unit of atomic weight to their pupils. Since no textbook can incorporate the change immediately, the present article, which is ensured prompt publication, has been commissioned.

The change is already permitted—even encouraged—in publications, providing it is clearly stated that the $^{12}C = 12$ scale is used. It appears virtually certain that physicists will be strongly recommended to use the scale from 1960 and that, as explained below, a similar recommendation to chemists will be confirmed at the 1961 meeting of the International Union of Pure and Applied Chemistry (IUPAC).

An historical approach best places the change in perspective. Early measurements of gas densities were,

* Reprinted by arrangement with the Chemical Society.

in effect, atomic weight determinations, and it was convenient to use the lightest gas, hydrogen, to provide the unit of gas density. Measurements of other gases relative to hydrogen could then be expressed on a convenient numerical scale. This scale, suggested by Davy in 1812, led naturally, after acceptance of Avogadro's hypothesis, to the earliest atomic weight unit, H = 1. In the middle of the nineteenth century newer methods of obtaining 'combining' weights were developed, the majority of which relied on combustion or reduction. They therefore involved the combination ratio with oxygen. Several oxygen-based scales grew up simultaneously, including those of Thomson (O = 1), Wollaston (O = 10) and Berzelius (O = 100). Confusion was increased by the lack of realization that both oxygen and hydrogen (gas) consist of diatomic molecules.

In 1885 Ostwald suggested that the atomic weight basis O = 16 would combine the advantages of both types of scale. It would retain the approximate numerical values of the H = 1 scale, in which all atomic weights tend to be convenient numbers, but yet would enable the majority of atomic weights to be stated with precision, inasmuch as they were experimentally related to oxygen with greater accuracy than oxygen itself was related to hydrogen. Inspired by Ostwald, the German chemical society sent a questionnaire to a number of chemists in 1899, and the replies are preserved in full[1]. The first question related to the basis of atomic weights, and the voting ran 7 for H = 1, 40 for O = 16 and 2 'don't knows' who favoured the coexistence of the two scales. The Chemical Society formed a Committee consisting of Thorpe, Tilden, Dunstan, Scott, Meldola, Crookes, Dewar and Russell who collectively were in favour of O = 16. In a further part of the questionnaire, workers were invited to air their views on the setting up of a committee to report regularly on atomic weights. This idea was favourably received, and the International Commission on Atomic Weights was subsequently born.

The first discovery of isotopes lay in the radioactive series and was not immediately seen to affect the basis of atomic weights. The discovery of stable isotopes and especially of oxygen isotopes was more important.

At first the trouble was thought to be negligible, and in their original paper on oxygen isotopes Giauque and Johnston[2] say: 'the presence of isotopes of oxygen will, of course, not affect chemical atomic weights except in the remote possibility of non-uniform distribution.' Within six years the 'remote possibility' was known to be significant. In a theoretical paper Urey and Greiff[3] concluded: 'the atomic weight of oxygen in carbon dioxide which is in equilibrium with gaseous water differs from that of the oxygen in the water by one part in one hundred thousand so that the standard of atomic weights cannot be regarded as constant within this limit.' In the same year, 1935, Dole[4] showed experimentally that oxygen in the air had an atomic weight of 16·00008, taking oxygen of Michigan lake water as standard. His conclusion reads: 'it is meaningless to quote the atomic weight of oxygen to more than four decimal places.' As these statements show, there is a logical defect in the definition of chemical atomic weights which has been known for over twenty years but not removed.

In the light of such isotopic variability it is seen to be pointless to quote atomic weights of 'natural' samples of the elements to high accuracy. Instead, experiments must be devised to determine separately the isotope abundance ratios and isotopic masses. For these masses an accurate scale is required. The important instrument for determining isotopic masses is the mass spectrograph. In the early 1920s, when oxygen was thought to be mono-isotopic, Aston used to relate all other masses to that of the dominant isotope of oxygen, which he took to be exactly 16 units. This scale was well established before the discovery of ^{18}O referred to above and its experimental convenience was such that mass spectroscopists continued to use this scale. It is still in wide use and is commonly called the physical scale of atomic weights. However, in the view of most nuclear physicists and mass spectroscopists, this scale ($^{16}O = 16$) today suffers from similar defects to that of the H = 1 scale in 1900. Techniques for the determination of exact isotopic weights have been modified; most nuclei are now closely related to ^{12}C, and the ratios of their masses to this nucleus are more exactly known than the ratio of ^{12}C to ^{16}O. The precision to which they may be expressed on a ^{12}C scale is therefore superior to that on the ^{16}O scale, which in its turn is superior to the precision on the natural oxygen scale. The reasons for this are technical and are related to the ease of obtaining ions in the mass spectrograph that contain many carbon atoms. Also isotopic masses may be deduced with accuracy by measurement of *Q*-values, that is, relating nuclei to each other by means of the energies of nuclear reactions, the relation between mass and energy being given by the theory of relativity. Again $^{12}C = 12$ is the most satisfactory basis.

To summarize the present position: chemists and physicists are each using a scale which they know to be unsatisfactory, and further, the existence of the two distinct scales in common current use leads to confusion and errors.

Consequently many informal and formal discussions have been held in the last few years, and the great majority of those who have studied the matter favour the new proposal of $^{12}C = 12$ (exactly) as the new basis. A joint committee of the Chemical Society and the Faraday Society, consisting of Briscoe, Dunning, Emeléus, Guggenheim, Walton and Whiffen, with Cahn as secretary, firmly recommended this scale to IUPAC, as did many chemists in other countries. IUPAC have recommended $^{12}C = 12$ on condition that the corresponding body for Physics at its 1960 meeting recommends this scale for use by physicists. If, as seems almost

certain, this recommendation is made, IUPAC will confirm its own recommendation in 1961. Other scales, *e.g.* $^{19}F = 19$, which have been discussed suffer considerable disadvantages.

For the physicists, the chief advantage is that of precision in quoting nuclear masses. Most indirect measurements involving these masses also involve Avogadro's number, and the ratio of these quantities is unaffected by the unit of atomic mass. The great majority of tabulated data of interest to physicists are consequently unaffected. For instance, accurate gas microwave spectroscopic data for diatomic molecules may be used in conjunction with isotopic masses to determine accurate bond distances. Since Avogadro's number is required in the calculation, the bond distance remains unaffected by a change of definition of the atomic mass unit. Incidentally, it is usual to quote an isotopic mass as the mass of the nucleus and sufficient electrons to make an electrically neutral atom.

For typical chemical problems it is common to quote results per gram molecule. Free energies, entropies, bond energies, heats of combustion, activation energies, molar refractivities, equivalent conductivities, latent heats, and many such quantities are related to the unit of atomic mass. These molar quantities are widely tabulated by chemists, and in accepting any change it is important that as many tabulations as possible should remain unaffected. The proposed change is so small that it meets this criterion, and the author can think of no tabulation of results which will be rendered obsolete, unless it be the atomic weight table itself. This is already revised and reprinted at frequent intervals, as are the physicists' isotopic mass tables. The change will cause no greater inconvenience than has been occasioned by the earlier, regular revisions. Since the direct chemical determination of accurate atomic weights by gravimetric procedures is now superseded, the relative unsuitability of the $^{12}C = 12$ scale for this purpose is unimportant.

The numerical difference between the old chemical scale ($O = 16$) and the new scale ($^{12}C = 12$) is such that the old atomic weights should be reduced by 43 p.p.m. (*i.e.* divided by 1·000043). No atomic weight will be changed by more than 4 in the last place quoted in the 1957 tables[5] and few of these are established with certainty to better than 5 in the last figure. Avogadro's number will be reduced[6] from $\boldsymbol{N}$ ($O = 16$) = 6·02322 to $\boldsymbol{N}$ ($^{12}C = 12$) = 6·02296 $\pm$ 0·00017 and the change is only one and a half times the uncertainty in the value. It is less than one-third of the change in the accepted 'best' value since 1951. The reduction in the gas constant is similar, and the same factor (division by 1·000043) is to be applied to the Faraday; this is more significant in that the Faraday is known to 10 p.p.m. Simple concentration-cell potentials are unaffected inasmuch as they are determined essentially by concentration ratios, which are unchanged. Cells with electrodes reversible to ions of different charge will have their potentials affected by a small multiple of

$$(\boldsymbol{RT/F}) \ln 1{\cdot}000043 = 1\mu\text{volt}.$$

Isotopic variation between different 'natural' samples can reach 20 p.p.m., and even if original publications specify the source sufficiently for identification purposes this is not normally reprinted in summarizing tables such as Landolt-Bornstein. In the future it is likely that all measurements of atomic weights to an accuracy of 50 p.p.m. or better will be made on materials of accurately measured isotopic composition. Since isotopic weights can be accurately determined on the new $^{12}C = 12$ scale, but not on the old $O = 16$ scale, the advantages of the change are expected to become apparent. It is therefore opportune that the change should be made now before the defects of the old scale become of practical importance, and that the change should be made to the $^{12}C = 12$ scale which is so suitable for mass spectroscopic measurements and which is so close to the old scale that very few measurements already made are affected by as much as their limits of error.

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PURE FOOD CENTENARY

Further details (see *J.*, 1959, 663) of the conference being arranged to celebrate the Pure Food Centenary in London from 20 to 23 September, including the titles of papers to be presented, have now been released. An exhibition at Charing Cross Underground Station will be opened by the Rt Hon. John Hare, Minister of Agriculture, Fisheries and Food, and a reception will be given to delegates at Lancaster House by H.M. Government on the evening of 20 September. There will be a Centenary Banquet at the City of London Guildhall on 23 September.

The papers to be presented will be read at the Royal Institution and will include: the 1860 Act and its influence on the purity of the world's food; pure food for people: the manufacturers' contribution; pure food and the commonwealth; international aspects of pure food and pure food legislation; national problems and the integration of food research.

Full details and registration forms may be obtained from the Secretariat, 14 Belgrave Square, S.W.1.

Book Reviews

HETEROCYCLIC CHEMISTRY. A. R. Katritzky and J. M. Lagowski. Pp. 274. *London: Methuen & Co. Ltd; New York: John Wiley & Sons Inc.*, 1960. 21*s*.

Several excellent books on various branches of chemistry have appeared during the past year or two but all too frequently a favourable review ends with an expression of regret that the price places the book beyond the means of the average student. In Katritzky and Lagowski's *Heterocyclic Chemistry* we have a book the price of which is well within the means of even the most impecunious student, and for this the authors and publishers deserve congratulations.

In the introduction the authors make some claim to present the subject with a new emphasis from the standpoint of the electronic theory which has proved to be so useful in the study of aliphatic and benzenoid chemistry. It is doubted if many teachers of organic chemistry will subscribe to the view that this method of approach presents any novelty or that the electronic theory has been so relatively neglected as far as heterocyclic chemistry is concerned. Further, it is a little disappointing to find that the electronic interpretation of mechanism and properties is in fact not a conspicuous feature of the text and that the mechanisms of the reactions by which heterocyclic rings are prepared from acyclic or carbocyclic compounds are intentionally excluded. The odd curved arrow appears here and there but in the main this volume consists of a mass of facts in a very concentrated form.

The subject matter is presented in an orderly and systematic manner. There is a useful introduction which explains the arrangement of the book and how it should be used, and which also includes a valuable bibliography of reviews and monographs for further reading. The main chapters deal with six-membered rings with one hetero-atom; six-membered rings with two or more hetero-atoms; five-membered rings with one hetero-atom; five-membered rings with two or more hetero-atoms; heterocyclic compounds with three, four, seven, or more members; and heterocyclic rings containing elements other than nitrogen, oxygen and sulphur. Each chapter contains sections on nomenclature and important compounds, synthesis and reactions. The text is full of formulae and while these are undoubtedly a valuable aid, they frequently make the reading of the text a difficult and disjointed experience. It is often impossible to read more than a line or two without searching for a formula which may be on another page. An enormous mass of factual information is provided in clear and concise terms and with remarkably few errors. In addition the text is commendably up to date. References to the original literature are not given except in a few cases of the most recent work.

The authors of this work set out to produce a useful book which would be inexpensive and they clearly realized from the start that this would necessitate a terse style, many abbreviations and some austerity in production. In this objective they have succeeded magnificently, and it can be said that the product of their labour is excellent value for money. There are some ugly formulae (as, for example, on pages 92, 181, 201 and 223) and it is difficult to believe that the advantages of the use of the unconventional representation for isoquinoline outweigh the disadvantages. The arrows on both sides of formula (162) on p. 216 are unnecessary and indeed misleading. These are, however, minor matters.

This is the second work under the title *Heterocyclic Chemistry* that has appeared within a matter of months. The earlier volume by Professor Adrien Albert and that by Drs Katritzky and Lagowski have little in common. The one can be read with interest from a comfortable armchair; the other requires not only a hard wooden chair but also a table, paper and pencil, which in a work intended primarily for the student is perhaps not a bad thing. If value is measured by facts per money spent then Katritzky and Lagowski find themselves well ahead, but those whose main interests fall within the field of heterocyclic chemistry will probably want to possess both volumes.

D. H. HEY

INTRODUCTION TO THE ORGANIC CHEMISTRY OF HIGH POLYMERS. C. S. Marvel. Pp. viii + 82. *New York: John Wiley & Sons Inc.; London: Chapman & Hall Ltd.*, 1959. 36*s*.

The rapid development of polymer chemistry during the past 30 years has resulted in many textbooks on the subject. Nearly all these are concerned primarily with physico-chemical aspects and few deal at any length, as this one does, with the organic chemistry of high polymers and the reactions concerned in their formation. Stress is also laid on the historical development of the subject. After a brief historical introduction there are short sections on definitions and the characterization of high polymers. These are followed by a section concerned with condensation polymerization in which polyesters, polyamides, phenol-aldehyde and urea-formaldehyde resins, polyurethanes, thiokols, epoxy resins and silicone resins are considered. Following this, two sections deal with additive polymerizations, initiated either by free radicals or ions. Others deal with co-polymerization and diene polymerization, and there is a final short but useful section on the reactions of high polymers.

Although the book is short, treatment is reasonably detailed and there are many references to the original literature. The text is concise, very readable and reasonably up to date, including consideration of interfacial poly-condensation and the use of Ziegler catalysts.

'Living' polymers and the recent development of high polymers from formaldehyde do not, however, appear to be included. Although, as the author states in the preface, the book is intended for the beginner in polymer synthesis, it gives perhaps rather more than the title would suggest and it will be read with interest and profit by polymer chemists generally. It provides a sound introduction to the subject and should be of particular value to students and those starting research in polymer chemistry. The price, however, seems very high for such a short book.

W. R. Moore

ORGANIC REACTIONS. VOLUME X. Edited by R. Adams. Pp. vii + 563. *New York: John Wiley & Sons Inc.; London: Chapman & Hall Ltd,* 1959. 96*s*.

The volume deals with three main subjects. Chapter 1, by S. M. Parmerter, is entitled the coupling of diazonium salts with aliphatic carbon atoms. This naturally covers a fairly extensive historical span and it is very useful and interesting to have this problem brought under review. Keto-compounds of all kinds, nitriles, sulphones, nitro-compounds and hydrocarbons are among the types undergoing coupling. Mechanisms are clearly discussed.

Chapter 2, by R. B. Phillips, is related to the first chapter, being on the Japp-Klingemann Reaction, in which coupling with diazonium salts is accompanied by elimination of an acyl or a carboxyl group. The facts are set out clearly, and mechanisms and practical applications are described.

The next chapter, by E. D. Bergmann, D. Ginsberg and R. Pappo, is a very comprehensive study on the Michael reaction. This important process is taken to include addenda and acceptors activated by groups other than carbonyl and carbalkoxyl. In this way, among donors are mentioned nitriles, nitro-compounds, sulphones and hydrocarbons such as cyclopentadiene, indene and fluorene, which have particularly reactive hydrogen atoms. As acceptors of the less formal types are certain hydrocarbons such as fulvene, a vinylsulphonium compound and a conjugated tetra-acetylenic hydrocarbon, acetylenic aldehydes, ketones and esters.

The historical aspect is well presented and notable analogies cited. The Robinson modification of the Michael reaction is illustrated. Attention is drawn to the use of strongly basic exchange resins as catalysts of Michael additions. A most valuable feature of the chapter is the inclusion of a very substantial list of systems that did not undergo condensation.

It is stated that little is known concerning the steric course of the Michael reaction, although the formation of asymmetric carbon atoms in open-chain products and the possibility of *cis-trans* isomerism in the case of alicyclic ones clearly offer scope for investigation. A considerable selection of examples is given to indicate the present state of knowledge.

There is a very extensive tabular survey of the generalized Michael reaction, and over a thousand references are given. This chapter is an extremely able piece of work and will greatly aid future investigators.

A useful feature is the provision of author and subject indexes to all the ten volumes of this work.

E. E. Turner

ANTIBIOTICS IN MEDICINE. *British Medical Bulletin,* 1960, **16**, (1), pp. xvi + 88. *London: The British Council.* 20*s*.

This number of the *Bulletin* contains a brief introduction by the editor, Professor L. P. Garrod, and 15 contributions by different authors on the nature and use of antibiotics. The term 'antibiotic' is not defined by the editor, and although he seems in practice to differentiate between substances of natural occurrence and those of synthetical origin, there is an implication in his introductory remarks that isoniazid and PAS are antibiotic substances. Bywaters, in his contribution on the preventive use of antibiotics, deliberately lumps together all antimicrobial agents, whatever their origin. Gale's definition of an antibiotic as 'a substance which is synthesized by one organism and is toxic to other organisms', would seem to include synthetic antimicrobial agents if an organic chemist is considered to be an 'organism'. Crofton's article is concerned with what constitutes 'good chemotherapy' in tuberculosis and he avoids the use of 'antibiotic' altogether, all chemical agents being termed 'drugs'. It is not perhaps a matter of great moment but clearly a number of contributors accepted the original restricted definition of the term and confined themselves to substances of natural origin.

The scope of the material covered in these articles is wider than the title would imply. Thus Abraham and Newton discuss the chemistry and classification of antibiotics in a most interesting contribution. 'The individual structures . . . appear to arise from a limited number of biogenetic themes and the latter provide a basis for a rational classification in chemical terms.' Most of the known antibiotic substances may then be derived from amino acids or similar units, acetate or sugars. Gale contributes a brief but stimulating discussion on the nature of the selective toxicity of penicillin, polymyxin and chloramphenicol. Pollock deals critically in his article with the nature of drug resistance and the mechanisms of its development. Apart from valuable contributions by Campbell on the search for new antibiotics, and Cruickshank on their laboratory uses, the rest of the *Bulletin* is mainly of interest to clinicians. The subjects dealt with include the principles of therapeutic use and the pharmacology of antibiotics, their preventive use in medicine and in surgery, the rationale of combined chemotherapy and the dangers of antibiotic treatment. Special articles are devoted to the treatment of tuberculosis and bacterial endocarditis.

The *Bulletin* is excellently printed with elegant formulae and clear illustrations. It will be welcomed by clinicians and by research workers in the field of chemotherapy. One reader would grant it a more cordial welcome if full-page advertisements were not inserted in the middle of articles.

VINCENT C. BARRY

FORTSCHRITTE DER ARZNEIMITTELFORSCHUNG (PROGRESS IN DRUG RESEARCH). VOLUME I. Edited by E. Jucker. Pp. 607. *Basel: Birkhäuser Verlag*, 1959. DM 68.

This volume is the first in a series promised annually. It is a compilation of six surveys on topics which are, with two exceptions, quite unrelated to one another. A seventh chapter reviews drugs for all purposes introduced during the past five years, or thereabouts. Two of the review articles are written in English, the remainder in German.

Let it be said at the outset that this is a book designed for those with a deep professional interest in chemotherapeutic research. In no sense does it set out to be a popular exposition of any aspect of the subject. The absence of an index testifies to this.

Chapter 1 (113 pp., 487 refs., J. Büchi) is nominally devoted to the application of ion-exchange resins in pharmacy and medicinal technology, but in fact it covers a much wider field, and is none the less valuable for doing so. Thus 60 pages are given to general theory. The remainder are packed tight with practice from the technical production scale down to the use of exchange resins as micro-analytical tools. The 17 pages devoted to the latter are of special merit and cover a wide range of applications from the determination of the components in sugar mixtures to codeine compound preparations. Some attention is given to a consideration of biological polymers (proteins, nucleic acids, mucopolysaccharides and so on) as exchange resins, and finally the direct application of synthetic resins in medicine is described, as excipients in drug formulations, as diagnostic indicators, and in their own rights as buffering agents or specific ion adsorbents.

Chapter 2 (31 pp., T.-M. Lin and K. K. Chen) is a review article, largely uncritical, on the much debated association of atherosclerosis with the pharmacology of cholesterol. The chaos existing in the present state of knowledge and hypothesis is well illustrated by the four-page list of 86 products (44 from the U.S.A., 1 from the U.K.) claimed to lower cholesterol levels or alter lipoid metabolism. Sixty various constituents are contained therein, of which perhaps three (sitosterols, unsaturated fatty acids and nicotinic acid) are agreed to be active. In this field, drug exploitation would seem to have outpaced drug research!

Chapters 3 and 4 are by H.-A. Oelkers (85 pp.) and von J. Bally (37 pp.), on the chemotherapy of worm infestations and newer aspects of anthelmintics, respectively. The two articles seem to have been prepared independently and, not unexpectedly, there is some overlap. But roughly the distribution is that the first contains much useful biological background at clinical, field and laboratory level, with the therapeutic discussion given largely to the synthetic remedies of proven value, while the second article has a wider drug ambit and includes many compounds both synthetic and natural which have never passed beyond experimental status. Together they provide a useful picture of the present-day position.

Chapter 5 (170 pp., H. Haas, H. Fink and G. Härtfelder) is an exhaustive, and exhausting, account of the use of the placebo in the clinical assessment of drugs, with the stress naturally on those influencing the higher centres of the brain. The considerable past, and current fast-growing literature has been searched and presented, often in great detail. This is quite definitely for the specialist.

Chapter 6 (86 pp., A. H. Beckett) is a highly condensed review of the author's special interest, the relation between chemical stereochemistry and biological activity, with special reference to conformational considerations. It covers not only drug action, where this is thought to be applicable, but enzyme effects, particularly those involved in metabolism, antigen–antibody systems, sympathomimetic agents, plant-growth substances and analgesics, amongst other topics. It makes most exhilarating reading.

The final chapter (77 pp., W. Kunz) is a general, but necessarily sketchy review of the newer remedies introduced during the five years up to 1958. Twenty-seven fields are covered. Nearly 300 drugs are formulated and these include steroid hormones and antibiotics. Considering the magnitude of the task, the outcome is remarkably good.

F. L. ROSE

CHOLINESTERASES—A HISTOCHEMICAL CONTRIBUTION TO THE SOLUTION OF FUNCTIONAL PROBLEMS. M. A. Gerebtzoff. Pp. vii + 195. *London: Pergamon Press Ltd*, 1959. 55*s*.

The distribution of cholinesterase activity in the various types of cells present in different tissues, together with the intracellular localization of the cholinesterases, is a field that has been much studied in recent years, and is one that is of considerable potential interest in connection with physiological function. This monograph, of 169 pages of text and figures, is largely an account of the work that has been carried out in this field by Dr Gerebtzoff and his colleagues in the Department of Anatomy at Liége University. Although a brief mention is made of the different histochemical methods that have been applied to the detection of cholinesterases, it does not include any detailed discussion of different methods, but merely sets out the

standard technique (butyrylthiocholine for pseudo-cholinesterase, acetylthiocholine for true cholinesterase, with DFP for inhibition of pseudo-cholinesterase) used in the author's laboratory.

The book is divided into three parts, dealing with the distribution of the cholinesterases present in blood and liver, in the nervous system and in other non-nervous tissues. It contains 125 black-and-white figures illustrating the observed distribution of both true and pseudo cholinesterase activity in a wide range of tissues. The author is clearly very aware of the limitations, and even the unreliability, of many histochemical techniques, and the conclusions that he draws from his findings are suitably guarded. It is, however, a pity that he has, in places, limited his treatment of the subject to the purely histochemical approach, since a number of important findings of physiological interest, obtained by different methods, that would have added to the overall treatment of his subject, are not included. Because of these limitations of approach it is not a book for the general student, but as a compilation of the extensive histochemical work carried out by this group it is of real value to the specialist in this field.

R. H. S. THOMPSON

BIOPHYSICAL SCIENCE : A STUDY PROGRAM. Edited by J. L. Oncley. Pp. viii + 568 + Index. *New York: John Wiley & Sons Inc.; London: Chapman & Hall Ltd*, 1959. 52*s*.

The articles collected in this large book resulted from a conference held for the purpose of considering the basic organization of living matter. The word 'biophysical' is employed to designate this field because of the physical approach used to obtained and analyse information. In fact, the range of material published in this book is so wide that the area of interest of any one person is likely to be appreciably more limited than that covered. Altogether there are 61 articles by 49 authors. As well as the many diverse subjects there is also a wide variation in approach, from that of articles in which the possibilities inherent in a particular system are discussed, to that of others in which much experimental data is set out. The contents of the book are so arranged that the first half deals with material normally included in biochemistry, and the second leads from sub-cellular to multi-cellular material. Throughout there is a frequent alteration of emphasis between structure and function.

This comprehensive book includes articles on the internal structure of macromolecules of biological interest (especially protein, using as a basis the structure of Corey and Pauling), by J. L. Oncley, and A. Rich. The physico-chemical properties of assemblages of macromolecules are then considered by P. Doty, S. A. Rice, D. F. Waugh, B. H. Zimm and J. D. Ferry, and weak bonding forces by L. E. Orgel and W. H. Stockmayer; J. C. Kendrew describes the over-all structure of the myoglobin molecule derived by X-ray crystallography. The methods of infra-red spectroscopy with reference to the analysis of the bond-structure of DNA is presented by G. B. B. M. Sutherland. The mechanism and results of enzymatic action in energy release and synthesis are discussed in a series of articles providing much detailed information by A. L. Lehninger, M. Calvin, R. B. Roberts, R. A. Alberty, H. Neurath, A. Kornberg and A. Meister. There is a theoretical discussion on the possibility of electron conduction in biological systems by M. Kasha, and P. Elias has another on information theory. The role of DNA in the genetic process is discussed by R. C. Williams, E. S. Lennox and C. Levinthal. The effects of radiation by photons or particles of high energy are then treated by R. E. Zirkle, E. Pollard, T. H. Wood and C. A. Tobias. The electron-microscopic structure of cellular components is examined by H. S. Bennett, F. S. Sjöstrand, H. Fernández-Morán, A. J. Hodge, F. O. Schmitt and M. J. Glimcher. Finally, B. Katz, C. M. Connelly, W. A. Rosenblith, O. H. Schmitt, T. H. Bullock and H. K. Hartline contribute a group of papers on the working of the nervous system of higher animals.

The excellent illustrations provided in every variety are most impressive and greatly facilitate the handling of this generous quantity of information.

P. FATT

ADVANCES IN CLINICAL CHEMISTRY. VOLUME II. Edited by H. Sobotka and C. P. Stewart. Pp. xiii + 387. *New York: Academic Press Inc.*; *London: Academic Books Ltd*, 1959. $12 (96*s*.).

This volume is the second of an annual series intended to present advances in human biochemistry both to the clinician, and to the practising clinical chemist. Both theoretical and technical aspects are covered in the individual articles.

Outstanding in this volume is the review by H. Peeters of Bruges on the principles and technique of paper electrophoresis, an article that is complementary to the one by Owen in the first volume, which reviewed the results obtained with the method. In Peeters' words: 'Probably no physiochemical method has ever been used so extensively with so little knowledge of its fundamentals. . . .' Anyone who has experience of paper electrophoresis will confirm this statement. There is no longer any excuse for it, as in his 134-page article Peeters covers both theory and technique at a level which has not to my knowledge been equalled previously. The first section deals with simple zonal electrophoresis on filter paper, and the practical value of this part is enhanced by the inclusion of tables of paper properties, useful buffer solutions, and fault-tracing.

The second section deals with continuous flow electrophoresis, a field which is as yet unfamiliar to the clinical chemist. Both sections are illustrated by a

considerable amount of original work, much of it previously rather inaccessible.

I found the article by W. H. Marsh on automation in the analytical laboratory of absorbing interest. Although concerned nominally with the estimations carried out in a clinical chemical laboratory, this review should be read by all who have charge of a routine analytical laboratory. The review covers basic analytical operations such as glassware washing, volume measurement, titration, weighing and so on, and shows how they may be systematized both to increase output and decrease the likelihood of error. The article concludes with an account of the more elaborate fully automatic analytical systems such as the Analmatic and the Auto-analyzer. Most of this material has not been collected into a single article previously.

Bigwood and his associates contribute a valuable article on amino-aciduria in man; which includes a critical account of technique, and a comprehensive review of the findings in many clinical conditions. The subject is an important one, and a review now is timely, as the analytical technique has become sufficiently standardized to enable valid comparisons to be made between the results of different groups. Bigwood and his associates give extensive tabulated data of such comparisons.

Reviews by Bessman on blood ammonia, by Forfar and Tompsett on the idiopathic hypercalcemia of infancy and by Billing on bile pigments in jaundice, complete a useful and well-produced volume.

C. J. O. R. MORRIS

LIQUID–LIQUID EXTRACTION. Second Edition. L. Alders. Pp. xiii + 209. *Amsterdam: Elsevier Publishing Company; London: D. Van Nostrand Co. Ltd*, 1959. 42*s*. 6*d*.

The second edition of this excellent monograph will be welcomed by design and research workers in the field of solvent extraction. Although the general scope and arrangement of the book remains similar to the first edition, there has been considerable expansion and improvement in the text. The object of the book is to provide details of (*a*) the measuring technique to be used in order to obtain the data necessary for extraction calculations; (*b*) the calculations and theories underlying them; and (*c*) the laboratory-scale operations which may provide information on the results attainable in the commercial application of extraction processes.

The first two chapters deal with phase equilibria and the relationships of ternary systems; they have been slightly expanded and methods of correlating phase equilibria data included. Chapters III, IV and V cover cross-current, single-solvent counter-current and two-solvent counter-current extraction, respectively, and have been considerably expanded and rewritten. The final chapter deals with reflux in extraction processes.

Each chapter contains a brief account of the principles of the process, followed by the development of design calculations based on the use of the extraction factor.

The extraction-factor concept has been considerably expanded and improved by the introduction of methods of calculation that take into account variations in distribution coefficient or variations in phase quantities. Much of this work is new and published in this book for the first time. For most industrial processes, and particularly for the processes employed in the petroleum industry, the concept of a constant extraction factor gives satisfactory results. The application of the method to systems in which the solvents are not entirely immiscible is illustrated for several systems, and the author shows that, for the system acetone–methyl isobutyl ketone–water, calculations based on a constant extraction coefficient give results in excellent agreement with those determined by the Hunter–Nash or Maloney–Schubert graphical methods. Methods are given by which changes in the extraction factor with changing phase relationships can be determined and used in the design calculations. Equations are developed for the various processes and permit the calculation of all design factors from a knowledge of the phase equilibria data.

A very brief account is given of the commercial-scale equipment used in solvent extraction processes. Unfortunately the author does not discuss the problem of 'scale up' from the laboratory to commercial operation. The Royal Dutch/Shell group have been especially successful in the development of large-scale liquid–liquid extraction processes and in particular have developed the Rotating Disc Contactor, originally described by Reman, to full-scale commercial operation. Some account of the relationship between full-scale process operation and laboratory-scale operation of this type of unit would be of considerable interest. This is, however, a minor omission in a book which takes the reader through the laboratory evaluation of phase equilibria to the many varied design calculations in which the data must be used. Despite the large amount of mathematics and occasional difficulties of translation, the book remains readable and interesting throughout.

FRANK MORTON

PROBLEMS OF METALLOGRAPHY AND PHYSICS OF METALS. Edited by B. Ya. Lyubov. Pp. 476. *New York: Consultants Bureau Inc.; Chapman & Hall Ltd*, 1959. 76*s*.

This is a translation of the fourth symposium held by the Metallography and Physics of Metals Institute of the Central Scientific Research Institute of Ferrous Metallography. It is devoted to research conducted in the period 1951–53. The papers are grouped into six sections of which the first is devoted to the study of liquid metals and crystallization processes, the fifth and sixth to the physical chemistry of metallurgical extraction processes and miscellaneous matters respectively,

and the remaining three sections contain work on phase transformations and heat treatment of alloys, the hardening and softening of ferrous alloys, and diffusion processes. These three sections have an inter-related interest which is of necessity lacking from the other groups, and, within the limits of a short notice, it may be reasonable to give them the major attention.

There is a lengthy report of the way in which the morphology of martensite varies from one alloy to another, together with reports on the kinetics of various 'isothermal' martensite reactions, but the major pattern of cross-linked topics would appear to owe much to Academician G. V. Kurdyumov, and runs from the problem of the hardness of martensites and cold-worked material, through the concept of bond strength (perhaps 'binding forces' would be a better term) as indicated by the characteristic temperatures estimated from X-ray diffraction experiments in which the effects of elastic strain, grain size and thermal vibration frequency are carefully distinguished. The concept of bond strength as derived from the X-ray work is then linked with thermodynamic measurements of lattice binding energy and there are signs of an attempt to relate these aspects of atom–atom interaction in the solid solution, through measured diffusion and self-diffusion values in binary and ternary alloys, to rates of isothermal transformation in steels. One is left with the impression that structural imperfections of the dislocation type are played down and it is not at this stage easy to weigh the value of a pattern of attitudes which neglects them. Nevertheless, the implications and possibilities are interesting.

The quality of translation is variable from one paper to another and in some instances technical terms are not translated very precisely. This makes reading laborious but should not be seriously misleading to an informed student.

H. J. AXON

THE ELECTROLYTIC AND CHEMICAL POLISHING OF METALS IN RESEARCH AND INDUSTRY. Second Edition. W. J. McG. Tegart. Pp. x + 139. *London: Pergamon Press Ltd*, 1959. 40*s*.

Though considerable research work has been carried out in the electropolishing of metals—the literature continuing to multiply correspondingly—few books so far have been devoted to the subject. That by Jacquet, pioneer in this field, is still perhaps the best, but it is somewhat restricted. The book by Dr Tegart, of which this is a second edition (the first appeared in 1956), is therefore to be welcomed.

It is a slender volume, but nevertheless the author attempts to cover both the research and the industrial aspects of the subject. There can be little doubt as to which of these two fields is the more familiar to the author. His treatment of the theory and research applications, which takes up the bulk of the text, is concise, comprehensive and eminently readable. The mechanism of electropolishing, the electrical characteristics of the polishing process and the factors influencing polishing conditions (potential difference, current density, temperature, time, agitation, surface preparation, etc.) are well presented. Laboratory techniques—principles and methods—are adequately described, and this section includes a very helpful chapter on the use of perchloric acid in electropolishing and the precautions necessary to reduce the inherent danger of this versatile electrolyte to a minimum. Perhaps the most valuable section of the book is a tabular presentation of laboratory methods of electropolishing a large number of the common, and some less common, alloys and metals, ranging from aluminium to zirconium. A chapter is also usefully devoted to chemical polishing and its application in the laboratory.

The industrial application of electropolishing receives comparatively scant and somewhat inadequate treatment. Less than 20 pages altogether are devoted to general principles and specific processes for treating some ten to a dozen common metals; chromium, gold, magnesium and zinc receive no more than two or three sentences apiece. Somewhat vague references are occasionally made; for example, 'suitable heating arrangements which must be used to control bath temperatures,' and the reader is informed that 'articles should be degreased either by vapour [presumably trichlorethylene] or aqueous alkaline solutions, rinsed and *nearly completely dried* prior to polishing.' Cast-iron equipment is advocated for electropolishing solutions containing more than 30 per cent water, and the somewhat naïve statement is made that any plant equipped for electroplating or anodizing can be employed for electropolishing 'since the requirements for racking and current distributions are similar for the three processes.'

While the author's forte cannot be said to rest in the industrial side of his subject, his treatment of the laboratory application of electro- and chemical polishing should commend this book, not only to those who are interested in research in this field, but also to the considerable army of metallurgists who are constantly in search of improved methods in applying metallographic technique. The publishers are probably depending (correctly) on the book fulfilling a widespread need, and no doubt feel correspondingly confident that purchasers will be prepared to pay 40 shillings for a slim volume containing no more than 115 pages of text together with a table (albeit a most useful one) of references which covers an additional 20 pages.

S. WERNICK

AUTOMATIC TITRATORS. J. P. Phillips. Pp. viii + 225. *New York: Academic Press Inc.; London: Academic Books Ltd*, 1959. $6.00 (48*s*.).

Since titration is one of the most powerful techniques available to the chemist, the successful performance of

titrations automatically is significant in helping to meet the analytical demands of the chemical industry. Therefore, despite any adverse comments, this publication is a worth-while contribution to such progress, for it brings together the many facets of the subject.

The author, a professor of chemistry at the University of Louisville, Kentucky, has rightly endeavoured to survey every design within his title. He includes all instruments working to, or recording, an automatically determined end-point, and distinguishes the larger plant instruments by the term 'fully automatic.' Two main chapters deal with titrator design and potentiometric titrators, others describe alternative electrometric, photometric and coulometric methods, while short chapters mentioning fully automatic titrators and commercially available instruments complete the book.

The majority of titrators mentioned, being semi-automatic, still require a partly-skilled operator to control their function. Perhaps this is why no emphasis is placed on the requirements for reliability, if complete trust in the results is to be possible. It is highly desirable that all such instruments should 'fail-to-safe,' if fail they must occasionally, for they may be handling corrosive or even toxic chemicals. It is therefore misleading to find 'energise-to-close' valves advocated for liquid flow control, for failure of these could cause thoroughly undesirable flows, or overflows, within an instrument.

Attention is frequently drawn to commercially available titrators, which can be expected to have been developed to the stage where the designer's loving care, so often needed to keep experimental equipment in operation, is no longer essential. Yet it is surprising that, among the line drawings and circuit diagrams, there is not one illustration showing the constructional form of these titrators. Some information presented is unfortunately erroneous, perhaps because the author, while compiling his manuscript, failed to make direct contact with at least one manufacturer mentioned.

Because of its chiefly descriptive approach this book will have an interest limited to those needing a review of the work which has been attempted. It is not likely to provide the solution to actual titration problems, except through the excellent comprehensive list of references following each chapter, which point to the original work; nor can it be regarded as a textbook, for the author has not been able to detail sufficiently the many instruments mentioned.

D. A. PATIENT

ANALYST'S POCKET BOOK. J. R. Majer. Pp. ix + 100. *London: Butterworths Scientific Publications*, 1959. 17*s*. 6*d*.

The book consists entirely of tabulated information likely to be of use to the analyst.

After a table of atomic weights come some 30 pages devoted to factors for gravimetric analysis of 43 commoner elements. This is followed by tables of equivalents of volumetric solutions for acids, alkalis and nine common titrants, ionization constants, solubilities and so on. Many of these tables are rarely found outside major works of reference, which are often very cumbersome.

This book of 100 pages will fit in the pocket, as claimed, and is usefully bound with a plastoic binding, allowing it to open flat. The tables are clearly printed on stiff paper, and are easy to use; all factors are accompanied by their 5-figure logs, and there is also a set of 5-figure log tables in the book. Surely, however, the two headings 'sought' and 'found' in the factor tables are the reverse of what one would expect.

No small part of the virtue of this book is its compactness, and therefore one cannot also expect it to be fully comprehensive. In any work involving selection, it is possible for a user to criticize omissions; in this case, no serious criticism can be levelled. Probably no analyst covering a wide range of problems will find every factor he would like; but most people will find all the tables they are likely to need, and a great majority of the factors in common use. It would be quite easy for any individual to add the small number of special factors he needed. The tables of indicators are unusually complete and very adequate. I would, however, like to see a few words on the choice of a suitable primary standard accompanying the table on p. 45, since there are often several possible choices.

The book should find daily use in every analytical laboratory.

From a teaching point of view, it is doubtful if factors should ever be used by students, since it is essential that the principles of calculation be fully understood. The main place of this book in teaching will therefore be in the preparation room.

D. G. COOPER

THE MEASUREMENT OF GRASSLAND PRODUCTIVITY. Edited by J. D. Ivins. Pp. viii + 217. *London: Butterworths Scientific Publications; New York: Academic Press Inc.*, 1959. 35*s*.

These twenty papers cover several aspects of grassland productivity and indicate the nature of some of the research activities now in progress on pasture. The problems of the research worker who needs critical data on grass production are considered. When grass yield is obtained from a series of cuts, both the date of cutting and its severity may influence the relative yields from differently treated plots. It is also shown that the value of yield data is enhanced when they are accompanied with digestibility, the digestibility of the organic matter throwing light on the quality per unit weight of herbage produced from different grass species.

There is no strict relation between plant yield and animal net profit from pasture, and the performance of the grazing animal is influenced by factors other than the

quantity and quality of the herbage. The skill of the grazier, the individuality and health of the grazing animal and other uncertain factors intervene. There is therefore the school of thought represented in this book that considers output as measured via animals to be no more accurate than that obtained by a cutting technique. Others maintain that results from mowing may be misleading as a guide to grazing value, and that simple measurement involving animals can be informative. No claim is made that one method of pasture measurement is better than another under all conditions, and the choice of the actual methods to be employed must be governed by several considerations, including the kind of information that is desired.

There is room for much improvement in herbage measurement technique, but any single technique, however perfect, must leave many questions unanswered. This is inevitable, seeing that the value of a pasture is not governed exclusively by its available nutrients; its palatability and its influence on the soil and succeeding crops are also factors of major importance.

Very short summaries of the discussions that followed the papers are included, but a fuller account of these would have been welcome as they evidently threw light on chemical problems referred to in the papers. Chemists whose work is related to the nutritive value of pasture will find useful and stimulating ideas in this volume.

R. O. DAVIES

CHEMISTRY FOR ENGINEERS: AN INTRODUCTORY COURSE. E. Cartmell. Pp. vii + 172. *London: Butterworths Scientific Publications*, 1959. 25*s*.

There are surely as many ideas and opinions about what should be the content of a course of chemistry for engineers as there are teachers who have to give the instruction. Frequently, insufficient attention is given to this 'service' aspect of the work of chemistry departments in universities and technical colleges; this book will undoubtedly give a lead in a direction which can profitably be followed.

It would be an easy matter to criticize any book of this title for glaring omissions or unnecessary inclusions, as well as for lack of, or too much, detail. It is a much more difficult matter, however, to write such a book, that would be immune from the sweeping disapproval of some and elicit the wholehearted support of others.

The book supports its main themes—power production and materials—with chapters on nuclear chemistry, atoms and molecules, chemical reaction, chemical fuels, metals, acids and bases, corrosion, water treatment, plastics, and friction and lubrication. The first two chapters are treated fairly fully, taking up a quarter of the book. Nuclear reactors are included, and there are numerous diagrams showing, for example, crystal lattices and charge cloud overlap in the formation of covalent bonds. Though there is much on the petroleum industry in the chapter on fuels, solid and gaseous fuels are also dealt with, and the author has included a section on the recent developments in rocket fuels. The last four chapters are concise elementary accounts, and, like the others, are written in such a way that the centre of interest is the engineering application of the chemistry, rather than the chemistry itself. Possibly the chapter on metals should have included something on alloys; aluminium is dealt with in about ten lines.

The difficulty of adequately teaching a subject in a limited time to non-specialists shows through clearly at some points in the book. For example, H_3O^+ is 'hydrogen ion' on p. 104 and 'hydroxonium cation' on p. 105, though this had been resolved on p. 102. Should one use activity or concentration? The question raises its head, is decapitated and entombed on p. 112.

The book is well written and produced, with clear diagrams and an attractive cover; the author has captured the feeling of excitement over recent developments and expectancy about the future. It should have a wide appeal in technical colleges, and among practising engineers, and grammar-school libraries would do well to possess a copy.

F. LESTER

TRACE TECHNIQUES, USING THE KIOOO CATHODE RAY POLAROGRAPH. VOLUME I. J. Hetman. Pp. 48. *Southern Instruments Limited, Camberley, Surrey*, 1959. 25*s*.

This is a set of precise instructions for a curiously heterogeneous collection of some thirty determinations of industrial importance, including such diverse processes as, for example, determination of vitamin C in orange, tomato, grape, lemon and blackcurrant juice; determination of iron in animal liver; simultaneous determination of copper, nickel and cobalt in pure iron; determination of cyanides in water; determination of nitroglycerine in pharmaceutics, and determination of uranium in monazites. It is purely a bench manual, with application only to the specific determinations involved; no theory is included, no indications are given of how the determinations might be extended to other problems. It must be concluded that the book is aimed only at the unqualified 'push-button' operator of the instrument.

Each determination is described under the headings: preparation of sample; basic (*sic*) electrolyte; determination; reference electrodes; instrument settings; interpretation of results; and (occasionally) remarks; and is illustrated by one or more polarograms.

A bibliography of some 60 references is included, but it is not clear to what extent the determinations described are related to the papers cited in the bibliography.

CECIL L. WILSON

FORTHCOMING INTERNATIONAL SCIENTIFIC AND TECHNICAL CONFERENCES. List No. 26. Pp. 46. *London: D.S.I.R.*, January 1960.

Institute Affairs

EXAMINATIONS, JUNE 1960

Graduate Membership, Part I

An Examination for Graduate Membership, Part I, will be held **on Monday and Tuesday, 20 and 21 June, 1960,** in London, and elsewhere at the discretion of the Council.

Entry forms will be sent as soon as they are ready to accepted candidates. **The last date for the return of Entry Forms will be Monday, 9 May, 1960.** No entry will be accepted if received after that date.

EXAMINATION RESULTS

Diplomas in Applied Chemistry

Examination in Branch E: The Chemistry (including Microscopy) of Food, Drugs and Water:

Examiners: Dr H. E. Archer, Mr T. McLachlan.

The examination was held at the University of London Examinations Laboratory, Brunswick Square, London, and at 30 Russell Square in the week beginning 8 February, 1960. Of the 6 candidates, 2 passed.

Pass List

Landsman, Sidney, A.R.I.C.
Palgrave, James Arnold, B.Sc. (Dunelm.), A.R.I.C.

Council: Date of Next Meeting.—It has been agreed that the first meeting of the Council after the A.G.M. be held on Friday, 20 May, 1960. This, being the third Friday in the month, is the normal date.

Graduate Membership: Designatory Letters.—At their meeting on 18 March the Council passed the following resolution:—

> 'That any person while he is a Graduate Member of the Institute be authorized to use after his name the letters **Grad.R.I.C.**'

Several other professional bodies have authorized the use of similar designations for their members in such grades. It seemed desirable that Graduate Members of the Institute should not be at a disadvantage in this respect, especially as the qualification required for, or represented by, membership of this grade is exceptionally high—the equivalent of a good (at least 2nd class) honours degree in Chemistry of a British university.

The letters 'Grad.R.I.C.' should now replace 'Grad.Mem.R.I.C.,' previously authorized (*J.*, 1959, 103) for use solely as an abbreviation in published advertisements, prospectuses and similar contexts.

R.I.C. Membership and Affiliation.—A statement by the Council on a possible new grade of membership, and category of affiliation, is printed on pp. 122-5.

Meldola Medal: Awards for 1959.—The Council, with the concurrence of the Society of Maccabaeans, has decided to make two awards of the Meldola Medal for 1959. The recipients will be:

John Ivan George Cadogan, B.Sc., Ph.D. (Lond.)
Thomas Cudworth Waddington, B.A., Ph.D. (Cantab.)

Citations and biographical notes will be published next month.

Dr Booth's Visit to India.—In the course of a business visit to India, Dr N. Booth, Vice-President, conveyed the greetings of the President and Council to the Deccan Section, the Eastern India Section and the Northern India Section. Dr Booth addressed members of these three Sections at Bangalore, Calcutta and Delhi respectively, and the personal contacts that he was thus able to make with them were greatly welcomed. The Bangalore meeting is reported on p. 154.

Institute Representatives.—The following *Fellows* have been nominated to serve on Chemistry Advisory Committees:

West Ham College of Technology: Mr A. J. Turnbull, in succession to Mr L. M. Miall.

Stretford Technical College: Dr M. I. Gillibrand.

PERSONAL NOTES

Honours and Awards

Dr R. Augustin, *Fellow*, of the Wright-Fleming Institute of Microbiology, St Mary's Hospital Medical School, has been awarded the degree of D.Sc. of the University of London for her work on the immunochemistry of hypersensitivity reactions to pollens and moulds (asthma and hay-fever), fundamental aspects of antigen–antibody interaction and diffusion in gels and the development of new micro gel-diffusion methods.

Dr A. T. Green, C.B.E., *Fellow*, formerly director of research at the British Ceramic Research Association, was given the Freedom of the City of Stoke-on-Trent at a ceremony on 31 March during its Jubilee Year.

Dr D. E. Hathway, *Fellow*, of the British Leather Manufacturers' Research Association, has been awarded the degree of D.Sc. of the University of London for his work in the field of the chemistry and biochemistry of secondary plant substances, and of antimetabolites.

Professor E. L. Hirst, C.B.E., F.R.S., *Fellow*, President of the Royal Society of Edinburgh, will receive the honorary degree of doctor of laws of the University of Aberdeen on 15 September.

Professor C. Kemball, *Vice-President*, of Queen's University, Belfast, has been awarded the Corday-Morgan Medal and Prize (*see* p. 156).

Dr J. F. McGhie, *Fellow*, a Reader at Chelsea College of Science and Technology, has been awarded the D.Sc. of the University of London.

Mr J. T. Marsh, *Fellow*, has been awarded the Perkin Medal of the Society of Dyers and Colourists for 'outstanding contributions to the practice and to the literature of textile chemistry.'

Sir Harry Melville, K.C.B., F.R.S., *Meldola Medallist*, *Fellow*, will receive the honorary degree of D.Sc. of the University of Birmingham during the degree congregation on 15 and 16 July.

Professor J. W. T. Spinks, M.B.E., *Fellow*, of the University of Saskatchewan, has been elected a Fellow of King's College, London.

Mr C. Waller, *Fellow*, of Ilford Ltd, has been elected a Fellow of University College, London, and has been awarded the Progress Medal of the Royal Photographic Society for 1959.

Sir Alec Zealley, *Associate*, chairman of the Remploy Corporation Ltd, has been elected a Fellow of University College, London.

Societies and Institutions

Mr M. Apley, *Associate*, a director of the Walker Chemical Co. Ltd, has been elected a Fellow of the Plastics Institute.

Sir Alexander Fleck, K.B.E., F.R.S., *Fellow*, has been appointed President of the Society of Chemical Industry for 1960–61 and will be installed at the Annual Meeting of the Society at Bristol in July.

Dr F. W. Gibbs, *Fellow*, Assistant Secretary (Scientific), has been elected a corresponding member of the International Academy of the History of Science. He was also recently appointed honorary lecturer in the history of technology at University College, London.

Professor D. M. Newitt, F.R.S., *Fellow*, has had the Fellowship of the City and Guilds of London Institute conferred upon him.

Dr D. M. C. Reilly, *Fellow*, chemical advertising and publicity manager, Food Machinery and Chemical Corporation, New York, has been elected president of the National University of Ireland Club of New York.

Dr W. P. D. Wightman, *Associate*, Reader in the History and Philosophy of Science, University of Aberdeen, has been elected a corresponding member of the International Academy of the History of Science.

Royal Society of Edinburgh.—The following *Fellows* have been elected Fellows of the Society: Dr J. A. Lovern, head of the lipids and by-products section, and Dr J. M. Shewan, head of the bacteriology section, Torry Research Station, Aberdeen.

Educational

Dr T. H. Elliott, *Fellow*, of the University of Malaya, Singapore, has been appointed to the newly-created Chair of pharmaceutics.

Dr J. K. Grant, *Fellow*, has transferred to the University of Glasgow in order to assist the Professor of Pathology at the Royal Infirmary, Glasgow, to establish a laboratory for the study of biochemical aspects of endocrine pathology.

Mr I. Jones, *Associate*, has left the Grammar School, Llangollen, to take up the post of senior chemistry master at the Grammar School, Caernarvon.

Mr Peter Sleightholm, *Fellow*, has been appointed senior lecturer in chemistry at Bolton Training College.

Consultant

Mr J. S. Merry, *Fellow*, has disposed of his interest in the firm of Alfred Smetham and has established an independent practice as analytical and consulting chemist at 18 Cook Street, Liverpool 2 (Tel. : CENtral 3860).

Public and Industrial

Dr J. N. Aldington, *Fellow*, on completion of the re-organization of Associated Electrical Industries, is now group managing director of A.E.I. (Woolwich) Ltd. He was recently appointed chairman of the London Electric Wire Company and Smiths.

Dr H. G. C. Bates, *Associate*, of Shell Chemical Co. Ltd, has been appointed chemical sales manager, Midland sales region.

Mr B. K. Blenkinship, *Associate*, chief chemist of the South African Breweries, Ltd, is at present on a tour of other countries studying the latest developments in quality control and brewing processes. He will attend the American Society of Brewing Chemists Convention in Minneapolis, and will arrive in this country on 5 June. He will return to South Africa in September.

Dr A. N. Bose, *Associate*, has been appointed superintendent of the Hindustan Steel Co. coke-oven plant at Rourkela, Orissa.

Dr J. G. M. Bremner, *Fellow*, has been appointed research director of Scottish Agricultural Industries Ltd.

Mr I. H. Chayen, *Associate*, of British Glues and Chemicals Ltd, has been appointed managing director.

Mr J. A. Connel, *Associate*, a director of Unilever Ltd, has been nominated as vice-chairman.

Mr H. M. Crighton, *Associate*, has left Harbens Ltd to take up an appointment as assistant works manager at Kirklees Ltd, Bury.

Dr D. K. Datta, *Associate*, has been appointed assistant superintendent of the Hindustan Steel Co. coke-oven plant at Durgapur.

Mr W. A. Dickie, *Fellow*, joint managing director, British Celanese Ltd, has resigned from the Board.

Mr S. J. Filipek, *Associate*, has recently been appointed superintendent, Building Materials Laboratory, British Railways Research Department.

Dr R. G. Heyes, *Associate*, has relinquished his responsibilities as personnel director of Imperial Chemical Industries Ltd, Plastics Division, but remains production director.

Mr J. M. Kershaw, *Fellow*, of Monsanto Chemicals Ltd, has been appointed alternate to Mr T. P. Berington on the Board of the Company.

Mr J. B. Kitchin, *Associate*, has been appointed personnel director of Imperial Chemical Industries Ltd, Plastics Division, in succession to Dr R. G. Heyes, *q.v.*

Dr D. T. Lewis, *Fellow*, formerly senior superintendent, chemistry division, Atomic Wepaons Research Establishment, took up his new appointment as Government Chemist on 1 April.

Mr J. McLaren, *Fellow*, has been appointed senior scientist and head of the Coal Research Establishment, Stoke Orchard, Cheltenham.

Mr L. A. Muirhead, *Associate*, of the Shell Chemical Co. Ltd, becomes head of the technical section, development department, on 1 May.

Mr J. R. Mullarkey, *Associate*, has taken up a post with the Research and Development Branch, Polychemicals Department, E. I. du Pont De Nemours, Wilmington, Delaware, U.S.A.

Dr S. M. Patel, *Associate*, has left the department of nutrition, Haffkine Institute, Bombay, to take up an appointment as laboratory manager, Hindustan Lever Ltd, Bombay.

Mr Michael W. Perrin, C.B.E., *Fellow*, chairman of the Wellcome Foundation Ltd, has been appointed chairman of the board of governors of St Bartholomew's Hospital London, by the Minister of Health.

Dr A. G. Roach, *Associate*, recently took up the post of chief chemist designate at R. Silcock & Sons Ltd, Liverpool.

Mr J. B. D. Robinson, *Fellow*, has moved to Tanganyika Territory, British East Africa, to take up the post of director, Coffee Research, in the Territory.

Mr Peter Scott, *Associate*, has resigned from his post at the Royal Eastern Counties Hospital, Colchester, to take up an appointment as biochemist in charge of the biochemistry department at Selly Oak Hospital, Birmingham.

Mr D. W. D. Sims, *Fellow*, of the National Coal Board, has been appointed area marketing manager of the South Western Division.

Mr L. Singleton, *Associate*, resigned as chief chemist of Phillips Yeast Products Ltd last December and has since been appointed research chemist in the biological department of Glaxo Laboratories Ltd.

Mr R. L. Stephens, *Fellow*, has left the John Wyeth Laboratories to take up an appointment as production and planning executive at Dalmas Ltd, Leicester.

Mr A. F. Thomson, *Fellow*, will succeed Mr A. C. Francis, *q.v.*, as chief analyst of Rowntree & Co. Ltd in May.

Mr D. W. H. Waite, *Associate*, has resigned from his appointments with Aspro-Nicholas Ltd and Ivers-Lee (G.B.) Ltd to take up an appointment as director and general manager of Pretested Products Limited, Rickmansworth.

Mr L. H. Williams, *Fellow*, a director of Imperial Chemical Industries Ltd, has been elected a deputy chairman of the company.

Section Activities

CUMBERLAND AND DISTRICT

Fifty Years of Plastics and Polymers. Dr T. T. Jones gave the Annual Schools' Lecture on this subject on 5 February at Whitehaven College of Further Education.

Plastics are by definition materials that can be shaped by flow and contain as the essential ingredient an organic substance of high molecular weight. Polymers are similar, but not necessarily solid or even organic. They mostly consist of chains of repeated links; as many as 100,000 links may be present, and this accounts for their remarkable strength. The simplest link or unit of construction is the methylene unit $-CH_2-$, chains of which can be produced by heating diazomethane, nitrogen and polymethylene being formed. Similarly the ethylene unit derived from ethylene will form chains of polyethylene, but here the chains are usually branched. This is addition polymerization. Substitution of radicals gives rise to new classes of compounds, *e.g.* polyvinyl chloride, polytetrafluorethylene or polymethyl methacrylate.

Condensation polymerization occurs when hydroxy compounds, for example, react with elimination of water. The process is analogous to ester formation but is not confined to hydroxy compounds.

In 1910–20 phenolic resins were developed as a result of the pioneer work of Dr L. H. Baekeland. Coal is distilled to yield tar oil and coke. From the tar oil, benzene and then phenols, and from the coke, water gas and then formaldehyde are produced. The phenol and formaldehyde react together, in the presence of catalysts such as acids and bases, with the elimination of water. The result is a mixture of long-chain molecules containing cross linkages. The phenolic resin can be ground and mixed with materials such as wood flour and with colouring materials. On moulding this mixture under compression and heating, further reactions take place and rigid well-shaped products result. Cloth and paper can also be impregnated with the phenolic resin to yield various products.

Fundamental research in 1920–30 led to the modern resins. Much of this work was carried out by Carothers in America. Cellulose acetate was also a product of this period.

In 1930–40 polystyrene, PVC, nylon and synthetic rubber appeared. Styrene can be made from coal via benzene and ethyl benzene. It is polymerized by heat and catalysts. Because of its hydrocarbon nature, polystyrene is resistant to chemical attack and has good insulating properties. It finds many uses therefore in the electrical industry. Addition of materials such as rubber reduces the brittleness of polystyrene and yields a series of very tough materials. Polystyrene is softened by heat (thermoplastic); it may be used for preparing complicated structures by injection moulding.

Acrilan is a co-polymer based on acrylonitrile. The polymerization is brought about by the presence of free radicals.

PVC has a high softening point and it is necessary to add a plasticizer before moulding. It is then similar to rubber and can be used for the manufacture of film, sheet, rod, tubing and so on. Polyvinylidene chloride forms fibres when pulled or stretched.

Nylon fibre was developed by Carothers. It is a polyamide and is produced by heating together hexamethylene diamine and adipic acid. The product is a poly-hexamethylene-adipamide, the unit being

$$-NH(CH_2)_6NH\cdot CO\cdot(CH_2)_4CO-$$

This is called Nylon '66.' Threads of the material can be cold-drawn to give tough fibres. The starting material is again coal.

A different polymer, called Nylon '2–10,' is formed from sebacyl chloride and ethylene diamine. Dr Jones gave a very convincing demonstration of the rapidity of the reaction. A solution of the diamine in water was added to a solution of the acid chloride in CCl_4. The polymer formed at the interface was then removed with forceps and a continuous thread of the polymer was drawn from the mixture.

In the 1940–50 decade there appeared polyethylene, Terylene, the silicones and fluoropolymers. Silicone plastics combine the properties of remaining soft at low temperatures with an exceptional resilience to shock. They may also be used at elevated temperatures. Throughout his lecture Dr Jones gave numerous demonstrations of the reactions he was describing, and there were many exhibits to view.

The vote of thanks was proposed by Dr D. W. Ockenden.

Inorganic Stereochemistry. On 25 February at the Whitehaven College of Further Education, Professor R. S. Nyholm, F.R.S., gave a lecture entitled 'Inorganic Stereochemistry.'

Professor Nyholm set out to show in his lecture how virtually the whole field of inorganic stereochemistry could be rationalized in terms of electron-pair repulsion. Starting with non-transition elements the simplest principles of electrostatic repulsion of like charges were used to determine the most favourable distribution of electron pairs in the valency shell around a spherically symmetrical inert gas-type core. The stereochemistry of molecules is then defined purely by the number of electron pairs that have to be accommodated; being linear for co-ordination number 2, plane-triangular for 3, tetrahedral for 4, trigonal-bipyramidal for 5, octahedral for 6 and pentagonal-bipyramidal for 7. By ascribing different relative repulsive powers to lone pairs of electrons as opposed to bonding electrons (including double and triple bonds) it is possible to account for deviations from the most symmetrical arrangements and to give a satisfactory explanation of the shapes of complex ions and molecules of the non-transition elements.

In the case of the transition elements, the situation is a little more complicated owing to the existence of non-bonding d electrons which, when added together, do not necessarily give rise to a spherical symmetry. The five d-orbitals are of equivalent energy in the absence of an external field but can still give rise to a spherically symmetrical shelf when the d orbitals are empty (d^0), half-full (d^5; spin-free) or full (d^{10}). In these cases the stereochemistry will be uniquely determined by the co-ordination number, as for non-transition elements. Under the influence of the electrical field of co-ordinating ligands the d-orbitals split into three d_ϵ orbitals and two d_ϵ orbitals with relative energies that will depend on the nature and disposition of the ligands. Four ligands approaching the central atom from the corners of a tetrahedron will interact more with the d_ϵ orbitals, thus raising their energy and causing electrons to enter the d_γ orbitals preferentially. The symmetry of the non-bonding d-shell will then be spherical for d^0, d_γ^2, d_γ^4, d^5 (spin-free), d^7 and d^{10}, these giving rise to a regular tetrahedral shape. With co-ordination number 6 the d_γ-orbitals point more towards the ligands and the splitting is revised so that the d_ϵ-orbitals are now those to be preferentially filled. This gives a regular octahedral arrangement for configurations d^0, d^3, d^5, d^8 and d^{10} with very slight distorted octahedra for d^1, d^2, d^6 and d^7. It was pointed out that this does not take into account the mixing in of upper states which can cause slight deviations from the predicted arrangement. The crystal-field-stabilization energy that the complex gains by accommodating electrons in the lower of the split d levels is larger for octahedral than for tetrahedral complexes, so that these are more commonly encountered. However, Professor Nyholm stressed that crystal-field-energy considerations are not always the dominating influence and concluded by giving examples of molecules in which the stereochemical predictions of crystal-field theory had to be modified by taking into account also steric effects, the polarizability of the ligand, charge-transfer considerations and the stabilizing energy of the directed σ-bond.

A lively discussion followed, in which the principal theme was the student's difficulties in recognizing and appreciating the different but complementary approaches to the structure of molecules as exemplified by the crystal-field theory and the molecular-orbital theory.

The vote of thanks was proposed by Mr C. J. Riley.

DUNDEE AND DISTRICT

Owing to the inclement weather in Dundee on 22 January (the city was cut off by road because of the snow) the lecture entitled 'Some Observations on Analytical Chemistry', which was to have been given by Dr J. Haslam, has been postponed.

Chemistry of Poisoning. On 26 February Dr A. S. Curry gave a lecture at the University of St Andrews on this subject. He was introduced by the Chairman for the meeting, Mr D. Lloyd. Dr Curry first described the general division of work in the North-East Region Home Office Forensic Science Laboratory. He then concentrated his attention on the particular crime of poisoning, and the chemistry of the analytical techniques associated with its detection. Poisons are divided into groups with similar physico-chemical properties, and several examples in each group were discussed. The audience were warned of the many sources of carbon monoxide in the home, the risk of accidental poisoning of young children and the dangers associated with over-indulgence in ethanol. Dr Curry described barbiturates and alkaloids with special reference to paper chromatography and the use of spray reagents designed to detect functional groups in the molecule. Finally, the detection and proof of identity of insulin in tissue by a combination of biological and chemical methods were discussed in relation to criminal poisoning. The lecture was illustrated with colour slides. After question time the vote of thanks was proposed by Mr R. H. McDougall (President of the University of St Andrews Chemical Society).

Theatre Visit. On 4 March members with their wives and friends spent an informal evening at the theatre, and enjoyed the light comedy, 'Breath of Spring,' by Peter Coke. After the show, coffee was served in the lounge and Mr J. Smart, Chairman of the Section, welcomed the guests.

East Anglia

Film Show. A film show was held at the Oriental Café, Ipswich, on 12 January. The films were: 'Small Scale Analysis'; 'Crystallisation'; 'Schlieren'; and 'Radioisotopes in Industry.'

Chemical Aspects of Nuclear Reactor Operation. Mr J. D. M. McConnell of A.E.R.E., Harwell, addressed a meeting held at Norwich City College on 25 February. The subject of his talk was 'Some Chemical Aspects of Nuclear Reactor Operation.' Dr E. C. Wood was in the Chair.

Mr McConnell outlined the organization of the U.K.A.E.A. and pointed out the distinction between the power reactors operated by this authority and those to be operated by the Central Electricity Generating Board. Mr McConnell gave a brief outline of the types of fuel, moderator and coolant used in the different kinds of power reactor, before going on to the main subject of his talk. The chemical problems were of two types—operational and research. As an example of the first he instanced the processing of irradiated uranium. The method used was to allow radiation to decay somewhat and then to dissolve the rods in nitric acid. The solution was then treated with Butex acidified with nitric acid, when hexavalent uranium and tetravalent plutonium were removed into the organic phase. The plutonium was then reduced and stripped out with more dilute nitric acid. Other processes which had received consideration were volatilization techniques, slagging processes, partition between molten metals and ion-exchange processes. The last-mentioned were unsatisfactory because of the effect of radiation on the organic resins.

As examples of research problems, Mr McConnell spoke of the use of beryllium 'cans' for the fuel rods, the possibility of using ceramic fuel rods in high-temperature reactors and corrosion problems in pressurized water reactors.

The talk closed with the showing of a film illustrating the various types of power reactors under investigation by the U.K.A.E.A.

After an interesting discussion, Mr W. C. Hanson proposed the vote of thanks.

Hull and District

Chemotherapy. A joint meeting with the Hull Branch of the Pharmaceutical Society was held on 11 March in the Chemistry Lecture Theatre of the University of Hull. Dr F. L. Rose, O.B.E., F.R.S., of Imperial Chemical Industries Ltd, Pharmaceuticals Division, gave a lecture entitled 'Chemotherapy.'

Dr Rose outlined the method of searching for new substances having high therapeutic effect. First one learns as much as possible about the biochemistry of the system under examination and then tries to make compounds likely to upset enzyme action and thus seriously affect the growth of bacteria. Examples of this approach were given.

The lecturer illustrated the frequent difficulty of getting a selected compound of known activity to the site of the infection, and this difficulty in some cases can prevent the use of what appear to be very active compounds. Dr Rose illustrated with graphs the use of various sulphonamides, particularly with relation to infections in the blood stream. The concentration of the drug in the blood over a period of time was illustrated and showed clearly the large effect of relatively minor changes in constitution of the basic drug.

Mr G. Colman Green was the Chairman for the evening. The vote of thanks was proposed by Professor N. B. Chapman and seconded by Mr J. E. Hindle.

Leeds Area

Open Meeting and Ladies' Night. The Annual Open Meeting and Ladies' Night, organized jointly with local members of the Society of Chemical Industry, was held in University House on 4 February. We were honoured by the presence of Dr D. W. Kent-Jones, who presided, and we were especially glad that Mrs Kent-Jones was

able to accompany him. The spacious rooms of the University Refectory provided ample accommodation for the large gathering.

In a few brief but witty sentences Dr Kent-Jones introduced the lecturer, Mr S. W. Butterworth, technical and scientific adviser to Joseph Rank, Ltd, who is well known in the area as a former Head of the Department of Food Technology at the Leeds College of Technology. Explaining his title, 'The Philosopher at the Breakfast Table,' Mr Butterworth reminded us that Oliver Wendell Holmes was in fact a professor of anatomy and physiology and that a philosopher is a lover of wisdom but not necessarily of knowledge. Whisking the coverings from two tables in front of him, he revealed on the one hand an appetizing breakfast tray set out with orange juice, porridge, kippers, bacon and eggs, buttered toast and tea, and on the other hand the chemical contents of these materials callously but stoichiometrically displayed in reagent bottles. He then proceeded to relate the one to the other in a racy discourse in which calories and chemicals, Captain Cook and citrates, Landraces (pigs) and long hundreds (of eggs), were intermingled and spiced with a sparkling humour that won the hearts of the lay sisters no less than of the scientific brethren present, while engendering a new respect for the wonders of science manifest in everyday life.

After the chairman had complained that the lecturer had made him think but ruined his eating, Mr J. J. Priestley, chairman of the Yorkshire section of the Society of Chemical Industry, expressed the thanks of the audience for a most entertaining and instructive lecture and their appreciation of the thought that lay behind the curtain of humour.

The meeting then adjourned for what had been advertised as a buffet supper but which turned out to be a good straightforward sit-down affair at which those present amply demonstrated that the earlier scientific approach had in no way detracted from the pleasures of gastronomy.

Before and after the formal proceedings members and their guests were able to inspect an interesting and attractive display of bakery products organized by Mr R. Archer and his colleagues of the Leeds College of Technology to whom the Section is much indebted.

Structural Chemistry of Platinum. A meeting was held at the University of Leeds on 15 February, Mr R. K. K. Fourness, Chairman of the Section, presided. Professor E. G. Cox, F.R.S., gave a lecture on 'Some Aspects of the Structural Chemistry of Platinum.' An interesting discussion followed, and Dr H. A. Fisher thanked the lecturer for a delightful talk which gave even outsiders a clear insight into a field in which inorganic and organic stereochemistry had united in an attractive series of compounds.

A summary of the lecture will appear shortly.

LIVERPOOL AND NORTH-WESTERN

Gas-Phase Oxidation. On 1 March, Dr C. F. H. Tipper of the University of Liverpool gave a lecture at Widnes College of Further Education. The Chair was taken by Dr Helena Bradbury.

Dr Tipper briefly reviewed the general mechanism of the gas-phase oxidation of organic compounds, such as hydrocarbons, especially with regard to the nature of the molecular intermediates responsible for the slow development of branching in the systems and the elementary processes involving free radicals that occur. He discussed some recent work on the use of the mass spectrometer and of carbon isotopes to determine the mechanism of oxidation and then described work in progress at the University of Liverpool on the nature and role of peroxides formed during the slow combustion of hydrocarbons. Simple organic peroxides may be separated and identified by paper-chromatographic techniques. When these techniques are applied to the oxidation products of hydrocarbons in the gas-phase it is found that hydroperoxides are present if the temperature of the reaction is below 340–350°C. With n-heptane, the main peroxidic materials formed are heptane-dihydroperoxide and its compounds with aldehydes. It is probable that the peroxides are at least partly responsible for branching below 350°C.

Agricultural Chemicals. A joint meeting was held with the Institute of Petroleum on 3 March in the Chester Public Library. The Chair was taken by the Vice-Chairman, Mr E. Myer. Mr H. D. H. Womack of the Shell Chemical Company Ltd gave a lecture on 'Agricultural Chemicals.'

He emphasized the need for agricultural chemicals by pointing out that the world population is increasing at so great a rate that vast quantities of extra food will be required and new houses and roads will inevitably reduce the area available for growing of food crops.

The lecturer then reviewed the use of fertilizers, weed-killers, insecticides and fungicides as aids to increased crop production. He mentioned how new agricultural chemicals were tested in the laboratory for efficiency, toxicity and residue hazards before production was considered.

Mr Womack noted the developments and uses of agricultural chemicals during the past 100 years in relation to the tremendous expansion in the agricultural chemical industry that has occurred since World War II. He then discussed the various groups of organochemicals employed in weed-killing and methods of application to the soil or the plant, as well as the mode of action of various types of insecticides and fungicides on the pest or disease.

The lecture concluded with a brief consideration of possible future developments.

After a lengthy discussion, the proceedings closed with the vote of thanks proposed by Dr J. B. Matthews.

Analytical Chemistry. A joint meeting was held at Carlett Park on 10 March with the Society of Chemical Industry and the Chemical and Physical Society of the Central College of Further Education. Dr J. Haslam of Imperial Chemical Industries Ltd, Plastics Division, gave a lecture entitled 'Some Observations on Analytical Chemistry.' The Chair was taken by Dr Helena Bradbury, after Mr H. R. Jones of the College had welcomed the visitors.

Dr Haslam began with potentiometric analysis, stressing the importance of the early work of Sand and outlining the older forms of manual potentiometry. He then described titrations in which the end-points were characterized by galvanometer null-points, and, further, automatic titrations to known pre-set end-points.

The lecturer discussed full-scale automatic titrations and gave examples of the application of this kind of titration procedure to the determination of calcium and magnesium in water and to the determination of chlorine in polymers.

He made observations on some newer colorimetric methods for the determination of ammonia, fluoride, phosphate, nitrite, chloride and –SH compounds.

Dr Haslam concluded his lecture by outlining some of the principles involved in gas–liquid chromatographic analysis and gave examples of the application of the procedure to the solution of problems associated with the plastics industry.

A lively discussion followed, after which Mr A. G. Jones, Chairman of the Liverpool Section, S.C.I., proposed the vote of thanks.

Anniversary Dinner and Dance. The Section's 41st Anniversary Dinner was held on 11 March in George Henry Lee's Restaurant in Liverpool and was attended by about 140 members and guests. The Chair was taken by Dr Helena Bradbury, and the Section was honoured by the presence of the President, Mr E. LeQ. Herbert. Professor T. P. Hilditch, C.B.E., a founder-member and permanent Vice-Chairman of the Section, proposed the toast of the Institute, to which the President responded. Dr Bradbury proposed the health of the new Graduate Members and Associates, 18 of whom were present as guests of the Section. The Dinner was followed by dancing; Mr H. R. Hones acted as M.C.

LONDON

The Use of Oxygen in Iron and Steel Making. A joint meeting with the Gravesend and District Engineering Society was held at the Mayfield Hall Annexe of the Gravesend Technical College on 12 January.

Mr J. R. Barr, Chairman, introduced Mr J. A. Charles who, after a short introduction to the manufacture of iron and steel helpfully illustrated by a chart, went on to mention some of the earlier theoretical considerations and the practical developments on the basis of liquid oxygen and of tonnage oxygen supplied via pipelines.

Mr Charles dealt with the subject under three main headings: oxygen enrichment in blast furnaces for both iron and ferromanganese production; oxygen enrichment of flames in the open hearth; and the use of oxygen in molten-metal refining.

He pointed out how production from the blast-furnace could be increased, and other advantages secured. The high temperatures necessary for ferro-manganese production were also more readily obtainable, with reduced loss of tin.

With oxygen more fuel could be burned in the same space, and the scrap could be fed into the furnace much faster to make use of the extra heat. Mr Charles dealt fully with the advantages of oxygen enrichment in molten-metal refining. Here he described pre-treatment, such as desiliconizing and dephosphorizing the blast-furnace metal, assisted melting and decarburizing in electric and open-hearth furnaces, and the use of oxygen in conversion processes adapted to both low- and high-phosphorus irons.

Particular attention was paid to the L-D top blowing technique and its modification for the treatment of phosphoric irons. The lecture was illustrated with slides.

Mr Lee proposed the vote of thanks and Mr Barr thanked the College Authorities for the facilities provided.

Thirty Centuries of Assaying. At a joint meeting with the British Society for the History of Science on 20 January, held at the Science Museum, South Kensington, Mr Frank Greenaway gave a lecture entitled 'Thirty Centuries of Assaying.' Mr F. C. Hymas was in the Chair.

Mr Greenaway said that assaying had been practised since antiquity, the purity of gold and silver being expressed by weight relations as long ago as 2000 B.C. There were biblical references to the loss in weight of impure gold in the furnace, and this trial by fire remained the basis of assaying for many centuries. Cupellation, which still survives as an assay method, has a longer continuous history than any other quantitative chemical process.

Although there are no written records of assaying during the first 1000 years of the Christian era, the economic value of the process must have ensured that the methods of fire-assay were handed on. Such methods were indispensable to the establishment and trial of coinage, and there was a premium on accuracy. Cupellation was well known in the twelfth century and used for the assay of silver collected as tax. Accounts of the fourteenth century describe the use of *aqua fortis* for the 'parting' of gold and silver, the carrying out of a 'blank' estimation on the lead used in cupellation to obviate errors, and give directions for the care of balances.

With the advent of printed books the traditions of the previous centuries were gradually revealed to a wider

public; in the metallurgical books of the sixteenth century (Probierbüchlein, Biringuccio, Agricola, Ercker, etc.) descriptions of complex operations appear in a detail which suggests that this process had been practised for some time. Precise details of the assay balance and weights were given, as for example by Ercker (1574), who also described good sampling techniques, and a method of control of liquation (recovery of silver from copper by partition between copper and lead) in which samples for assay were withdrawn from the furnace at intervals. In the large mining centres of central Europe assays were carried out at the rate of hundreds in a week.

As commerce developed the art or craft of the assayer was recognized as essential and accepted as a natural part of the economic life of a community. In the eighteenth century assaying influenced, and was influenced by, the increasingly scientific character of chemistry. In 1760, as a result of the discordant assays of two official assayers, a commission was established in France to enquire into the methods used; one of its members, Tillet, carefully investigated and reported on the various possible sources of error or non-reproducibility in cupellation and devised a method of controlling the temperature of the furnace. In technique, and especially in the construction and use of the balance, assayers were often in advance of their contemporary chemists in the seventeenth and eighteenth centuries. In the early times, assaying had been little more than refining in miniature, but the scale of the assay had been reduced over the centuries until quite small weight differences were involved.

The first critique of dry assay from a chemical point of view was that of Bergman, who systematically explored precipitations of various metals. His work is one of the principal antecedents of that of Guy-Lussac, who in 1832 established argentometry, which is an outstanding early example of volumetric analysis, as well as marking the point of convergence of the tradition of the assayer with the new chemistry of the Lavoisier–Dalton epoch. Nevertheless, fire-assay of gold retains its value to the present day, and one of the most ancient devices, the touchstone, is still in occasional use.

An animated discussion followed the lecture, after which the Chairman called upon Dr E. Ashworth Underwood, President of the British Society for the History of Science, to propose the vote of thanks.

Opportunities in Chemistry. Mr Hymas took the Chair at a joint meeting with the College Chemical Society at Brighton Technical College on 29 January, when Dr J. H. Skellon spoke on the educational aspects of the subject and Dr F. Hartley on the industrial.

Dr Skellon and Dr Hartley addressed an enthusiastic audience that included staff and students from most of the Grammar Schools within 30 miles of Brighton.

Dr Skellon began by discussing the two major educational aspects of interest to students: *training opportunities* accessible to young people with various educational backgrounds, and *opportunities for careers in the teaching profession.*

For the qualified chemist, whether the holder of a University degree, the Grad. R.I.C., or a Diploma in Technology, the new Membership of the College of Technologists (M.C.T.) offers exciting possibilities for a qualification of high distinction based on advanced work carried out under the combined supervision of an industrial concern and a College of Technology. Alternatively, the young chemist may gain academic advancement by conducting research along more traditional lines and submitting his results for a post-graduate degree or the new Research Diploma of the Institute.

Speaking next of the younger student and the junior chemist in employment, Dr Skellon outlined the various routes leading to professional status, via a University degree, Grad. R.I.C., National Certificates, and the newly-instituted Diploma in Technology. He described in some detail the objects, scope and implications of this new award; the holder of a Diploma in Technology was, in his opinion, in a better position than a newly-graduated university student as regards accepting responsible work in control, research and development.

The teaching profession offers abundant opportunities to those attracted to it. Dr Skellon commented on the conditions and prospects of teachers in schools, colleges of technology and universities, mentioning, in particular, the improved conditions now existing in the colleges of technology. In these institutions teachers are provided with facilities for research; their work brought them into intimate contact with industry, and opportunities existed for study abroad. Thus, the teacher has every encouragement to expand and broaden his outlook and experience.

In conclusion, Dr Skellon claimed that opportunities in chemistry in the educational field compared favourably with those in industry.

Dr Hartley, in his introductory remarks, stressed the diversity of scope for chemists in industry where opportunities are offered to men and women of all intellectual levels.

Industry presents many facets: production and control, research and development, technical aspects of sales, library and patents work, all requiring the services of chemically trained men and women. The chemist concerned with developing and applying his specialized knowledge is designated a technologist; he requires the assistance of the technician who has acquired skill in certain techniques.

Research and development are usually conducted by chemists and their assistants working in teams under the direction of a hierarchy of senior chemists progressing from team leader through section leader to director of research. Research is not all glamour; it may often be exciting and satisfying, but it is not without its

phases of frustration and even depression. A prior training in postgraduate research is very desirable for the chemist entering industrial research; he would also be well advised to acquire a knowledge of another discipline, such as engineering, mathematics, biology, metallurgy, administration or law. Other attributes that will help to advance his promotion are personality and leadership.

Production and control offer the greatest scope for the chemist or chemical engineer who has imagination, initiative, organizing capacity, and ability to manage men. The successful man may expect great opportunities for advancement with substantial salary rewards.

Analytical control has a very important function in industry and provides an attractive field for physical, inorganic and organic chemists at all levels. Many technicians are absorbed into routine quality control, but real scope exists for technologists in an investigational and developmental capacity.

Technical services and technical sales offer the greatest scope for versatility. Qualities sought in this section are clear and concise expression in speech and writing, ability to deal with people, interest in a diversity of problems and in travel.

The Patents division and Library services provide stimulating and satisfying careers for chemists attracted to this type of work.

Dr Hartley referred again to the diversity of scope for chemists in industry with opportunities abounding at all levels. He considered that the demand for chemists in industry would continue to grow. Although, possibly, it is not so secure as teaching, industry provides many compensations that will continue to offer rewarding careers that few will regret having entered.

The vote of thanks to the lecturers, proposed by Mr Alan Witt, was carried with acclamation.

Film Show. A film show was held on 3 February at the South-West Essex Technical College, Walthamstow. Members and visitors were welcomed by the Head of the Science Department, Dr S. Lewin, who introduced the chairman for the evening, Mr R. W. Jukes.

The following films were shown: 'Discovery of a New Pigment,' 'Criticality,' 'A Vitamin Emerges' and 'A Story of Copper.' Mr Jukes expressed the thanks of the audience to the Principal and Governors of the College.

Water-Repellent Surfaces. A joint meeting with the Kingston Technical College Chemical Society was held on 4 February. After Mr I. Muten, Chairman of the College Chemical Society, had welcomed the guests, Mr P. A. Raine took the chair.

Professor N. K. Adam, F.R.S., first gave a brief survey of the practical applications of water-repellent surfaces followed by an account of the underlying physics of water repellency, showing the derivation of Young's equation $W_{SL} = \gamma_L(1 + \cos\theta)$ where W_{SL} is the work required to separate the solid from the liquid, γ_L is the surface tension of the liquid and θ is the angle of contact. He mentioned the importance of distinguishing between W_{SL} for the solid surface, free from an adsorbed film of liquid (via vapour), and W_{SL} for the solid surface with this film.

The largest contact angles normally obtainable for water surfaces are found when the solid surface consists entirely of CH_3 groups, as in solid paraffins. Angles of up to 110° are obtained on these, but smaller angles (*ca* 94°) are found where many CH_2 groups are exposed, as in polyethylene. Stearic acid behaves in an interesting manner, giving contact angles of 100–105° on a naturally solidified surface, but on cut surfaces angles that may be as low as 50° because of the exposure of COOH groups.

Professor Adam discussed contact-angle hysteresis: the angle of contact for a liquid advancing over a dry surface is always greater than θ for the liquid receding from the surface.

The very great and permanent water-repellency of a number of natural surfaces (such as the feathers of waterfowl, the surfaces of the water-plant Salvinia and the plastron of underwater-living insects) is explained by the work of Cassie and Baxter, who showed that unusually high average angles of contact could be obtained on surfaces pierced by very small, regularly spaced holes. They showed that in surfaces where numerous holes of about 5–7 μ diameter were evenly spaced, $\cos\bar{\theta} = f_1 \cos\theta - f_2$, where f_1 is the fraction of area where the liquid touches the solid and f_2 is the fraction in contact with air in the holes.

The lecture was concluded with a series of slides showing the arrangement of the barbules on feathers, and hairs on the plastron of an insect, giving an effect similar to that of the surface investigated by Cassie and Baxter.

After a discussion, in which eight members of the audience took part, the vote of thanks was proposed by Mr N. Lindop and carried enthusiastically.

NORTH LANCASHIRE

Chemical Bonding in Compounds of the Transition Elements. On 18 February in the Municipal College, Blackburn, Professor H. C. Longuet-Higgins, F.R.S., of the department of theoretical chemistry, Cambridge, gave a lecture entitled 'Chemical Bonding in Compounds of the Transition Elements.'

The transition elements form a wide variety of stable compounds which have no analogue in the chemistry of non-transitional elements. In order to understand the stability of compounds such as the ferrocyanides, the carbonyls and the bis-cyclopentadienyls it is necessary to postulate some kind of covalent bonding beyond the simple donation of unshared electron pairs from the ligands to the central metal atom or ion. This additional bonding is now known to involve the *d*-electrons of the

metal atom; these electrons can be 'back-coordinated' into empty molecular orbitals of the ligands. Geometrical considerations are essential to a real understanding of this phenomenon, and one finds that in octahedral complexes the additional bonds formed by back co-ordination are bonds involving orbitals which are antisymmetric with respect to a plane containing the central atom and the ligand. Only three out of five *d*-orbitals of the metal can take part in this type of bonding.

The bis-cyclopentadienyls, of which ferrocene is an outstanding example, may be described in similar terms. Here the union of a ferrous ion with two cyclopentadienate ions involves partial donation of the two aromatic sextets into the valency orbitals of the metal, accompanied by a certain amount of back-coordination from suitably disposed *d*-orbitals of the metal into the vacant molecular orbitals of the two rings. The same type of situation occurs in chromium dibenzene, and it was anticipated a few years ago that cyclobutadiene could be firmly joined to a transition-metal atom by the same kind of mechanism. This prediction has recently been confirmed by preparation of a transition-metal complex containing the cyclobutadiene ring.

The Growth of Fluorocarbon Chemistry. On 11 February in the Municipal College, Burnley, Professor R. N. Haszeldine of the Manchester College of Science and Technology gave a lecture entitled 'The Growth of Fluorocarbon Chemistry.'

In the early part of his address, Professor Haszeldine reviewed the mineral sources of fluorine and showed some slides of Roman antiquities made from 'Blue John' mined in Derbyshire.

He then discussed the reactivity of fluorine and some of its compounds and showed, by comparison of their respective atomic radii, how one could account for the inertness of fluorocarbons both to inorganic and organic reactants. Owing to the differences in the properties of the hydrogen and fluorine ions it was possible to predict and to develop a new branch of chemistry.

He concluded with many examples of fluorocarbon products: polymers, novel prepacked sprays and fire extinguishers based upon simple, non-toxic fluorocarbons and pharmaceuticals in which the replacement of H or OH had a remarkable effect upon the original compound.

Dr A. E. Wales, Principal of the College, proposed the vote of thanks to the lecturer for an interesting and stimulating lecture.

SHEFFIELD, SOUTH YORKSHIRE AND NORTH MIDLANDS

Some Aspects of Peptide Chemistry. A meeting was held on 27 January in the Assembly Hall of the Rotherham College of Technology. Mr C. Fox, a member of the Chemistry Department of the College, gave a lecture on 'Some Aspects of Peptide Chemistry.' Dr A. S. C. Lawrence was in the Chair.

Mr Fox introduced his lecture with an account of the analytical chemistry of proteins and the relationship of the proteins to the peptides.

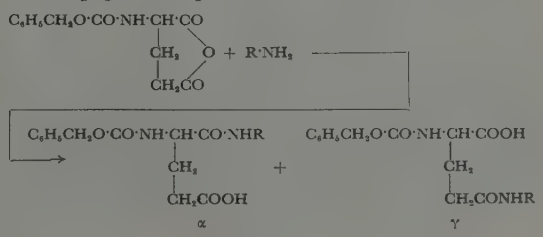
The logical progression from amino-acid analysis is the determination of amino-acid sequences in protein and peptide chains. The introduction of the FDNB method of end-group analysis, by Sanger, in 1945, together with techniques of partial hydrolysis of proteins or polypeptides into smaller fractions, made such determinations possible, although not necessarily easy.

As an illustration, the determination of the complete structure of insulin, by Sanger and Tuppy, was discussed. This was a particularly suitable protein for study, since it has a low M.W. ($\sim$ 6,000) and tryptophan and methionine are both absent. By means of the FDNB method, it was soon established that insulin contains two different peptide chains, one with a glycine *N*-terminal residue, and one with a phenylalanine *N*-terminal residue, the peptide chains being cross-linked by disulphide bridges of cystine residues. Sanger used performic acid to cleave the disulphide bridges and thus obtained cysteic acid peptides, which were eventually identified by means of partial acid hydrolysis and enzymatic hydrolysis, and identification by means of chromatography and electrophoresis.

The positions of the disulphide bridges were determined by hydrolysis of unoxidized insulin, after overcoming difficulties brought about by a rearrangement reaction involving such bridges.

Mr Fox then went on to discuss the methods used for the synthesis of peptides. This work was initiated by Fischer in an attempt to discover whether synthetic chains of amino acids would have the general characteristics of proteins.

One of the disadvantages of the earlier methods was the difficulty of removing the group used for protection of the free α-amino group, without disturbing the new peptide linkages. This problem was solved by the introduction of an efficient means of protecting the amino group by means of carbobenzyloxy chloride, the carbobenzyloxy group being readily removed by catalytic hydrogenation. One problem in this method of synthesizing peptides is the ambiguity when preparing glutamyl and aspartyl peptides. In general, a mixture of two peptides is produced as follows:



This particular aspect of peptide synthesis is being investigated at Rotherham College of Technology, in collaboration with the Biochemistry Department of the Queen's University, Belfast.

Carbobenzyloxyglutamic anhydride is condensed with ultraviolet-absorbing bases, *e.g.* glycine-β-naphthylamide, to give products capable of analysis by spectrophotometric methods. Separation of the peptide mixtures has been attempted by partition chromatography, electrophoresis and ion-exchange methods. It appears that the proportion of each type of peptide in the reaction depends upon the temperature and reaction solvent. By adjustment of these two variables, it may be possible to control the direction of the reaction and thus obtain one pure product instead of a mixture.

Mr Fox concluded his lecture by pointing out that as yet no protein had been synthesized, but such an achievement might not be far off, in view of the rapid progress now being made in this field.

Ladies' Evening. The Section held a Ladies' Evening at the Royal Victoria Hotel, Sheffield, on 23 February. The Chairman, Dr A. S. C. Lawrence, presided, and introduced Professor J. B. Speakman, University of Leeds, who gave a lecture on 'Permanent Waving.' Professor Speakman outlined the history of permanent waving, and went on to discuss the chemistry of the process, with interesting asides into related topics in the textile industry. Having satisfied the professional curiosity of the chemists, the meeting became less formal, and a demonstration was staged by Miss Jane Lindsay who showed styles suitable for various ages and types of hair. After a lively discussion the vote of thanks was amusingly and appropriately proposed by Dr J. McKenna, and the evening concluded with light refreshments.

THAMES VALLEY

Cyclobutadiene. At a joint meeting with the Alembic Club on 15 February in the Inorganic Chemistry Lecture Theatre, University of Oxford, Dr J. F. W. McOmie of the University of Bristol delivered a lecture entitled 'Cyclobutadiene—a success story.'

The Chairman, Dr F. M. Brewer, M.B.E., Lord Mayor of Oxford, before introducing the speaker, proposed that a letter of congratulation be sent to Dr D. T. Lewis, Chairman of the Section, on his recent appointment as Government Chemist.

Cyclobutadiene has aroused interest because of the possibility that it might show aromatic properties similar to those of benzene as it also contains a cyclic system of alternate double and single bonds. Although it is often stated that many attempts have been made to prepare the compound, in fact only three reported attempts had been made before 1957. Willstätter and van Schmaedel in 1905 tried the action of potassium hydroxide, and of quinoline, on cyclobutene dibromide and obtained acetylene and buta-1,3-diene, respectively. Another unsuccessful attempt was made by Buchman *et al.* in 1942. These failures were not due to excessive strain in the 4-membered ring since both 1-phenycyclobutene-2,3-dione and 1,2-dihydroxycyclobuten-3,4-dione, both of which are strained to about the same extent as cyclobutadiene, had been prepared.

Recent attempts by the speaker, and by other workers, to prepare di- and tetra-phenylcyclobutadienes, were then described.

In 1957 Nenitzescu *et al.* repeated and confirmed Willstätter's experiments. They carried out five reactions which might have yielded cyclobutadiene, but the only gaseous product was buta-1,3-diene. Nenitzescu suggested that in his, and in one of Willstätter's experiments cyclobutadiene had been formed, but at the high reaction temperatures used it had behaved as a diradical abstracting two atoms of hydrogen from neighbouring molecules whilst simultaneously ring fission had occurred to give buta-1,3-diene. Very recently Nenitzescu prepared a compound which is thought to be the silver nitrate adduct of cyclobutadiene.

At about the same time Griegee and his collaborators had studied the synthesis of tetramethylcyclobutadiene and had finally succeeded in preparing a nickel chloride adduct of this compound. The structure of the nickel complex had been proved by chemical and by X-ray crystallographic methods.

At the end of the lecture there was a lively discussion during which a number of possible methods were suggested for isolating cyclobutadiene and tetramethylcyclobutadiene from their metal complexes. The vote of thanks, proposed by Dr E. S. Lane, was carried with acclamation.

DECCAN

Research in British Industry. At a meeting of the Section held on 4 February in the General Chemistry Lecture Hall of the Indian Institute of Science, Bangalore, Professor M. R. Aswathnarayana Rao took the Chair and welcomed Dr Norman Booth, a Vice-President of the Institute and Managing Director of British Oxygen Research and Development Ltd, London. After his introductory remarks, the Chairman requested Dr Booth to address the gathering. Dr Booth spoke on 'Research in British Industry.'

He began by pointing out that research is the process of extending the bounds of knowledge and development is the practical application of new knowledge. In industry the ultimate objective is the development work, and research information may be obtained from many sources outside the industrial concerns as well as from the industry's own research laboratories.

British industry is a mixture of public and private enterprise and ranges from very large to very small

firms. Fifty per cent of the production of the United Kingdom comes from firms with less than 500 employees and 25 per cent from firms with less than 100 employees. On the whole the chemical industry tends to be in fairly large units.

The expenditure by British industry on research and development for 1955 was about £74m and, in addition, there were considerable sums spent by industry on Government contracts. The universities, research associations and so on spent about £16m, and the total figure for research and development expenditure, other than for defence, was rather less than 1 per cent of the United Kingdom's gross domestic production. The ratio of research to development costs in British industry varies from 10 : 1 to 1 : 200 but perhaps an average figure is 1 : 10.

Research and development work is conducted by industry, partly to improve existing processes, partly to improve existing products, to develop new processes for the same product and new products for the same use or for new uses. The organization of research and development varies very much from firm to firm and depends on the nature of the business and on the size of the firm. Clearly a firm employing, say, 100 people cannot afford to have a large scientific department but should aim to have at least one qualified scientist.

The economics of scientific developments provide in industry a pass or fail test. All good ideas cannot and should not be exploited. The fact that a product or process is new or improved is not sufficient reason for adopting it. It is always advisable at as early a stage as possible to make a preliminary economic calculation to see whether a subject is worth pursuing. One has to assess the probability of success and the rewards to be achieved, and also consider the cost of doing the work. Another point to bear in mind is that it is often difficult to identify an innovation. Many industrial processes are in the course of continual improvement and just when an innovation takes place and how much of it is due to the application of science it is often difficult to say.

The lecture was illustrated with slides. After a lively discussion, Dr B. H. Iyer proposed the vote of thanks.

The members and guests afterwards met Dr Booth at tea and spent an interesting hour discussing with him matters of professional interest.

EASTERN INDIA

Annual General Meeting. The Sixth Annual Meeting of the Section was held on 16 July, 1959, at the School of Tropical Medicine, Calcutta. As the Chairman, Dr J. W. Whitaker, was unable to be present, Dr N. K. Sen presided over the meeting. The Chairman paid a warm tribute to the memory of the late Mr K. B. Sen, Hon. Secretary of the Section, and read the resolution passed at the condolence meeting of the Committee held on 28 April, 1959.

The report of the present Hon. Secretary, Dr A. B. Sen Gupta, together with the audited statement of accounts for the year 1958–59, was adopted. All the four retiring members including the present Hon. Secretary, who was appointed towards the end of the year to fill the vacancy caused by the death of Mr K. B. Sen, were re-elected to the Committee.

Messrs Pal & Roy, Chartered Accountants, Calcutta, were re-elected Hon. Auditors for 1959–60.

Electrothermic Industries in India. After the business meeting, Mr D. S. Naidu, chief chemist at the Calcium Carbide Factory, Birlapore, West Bengal, gave a talk on 'Electrothermic Industries in India.' Mr Naidu dwelt on the need for the establishment of electrothermic industries in India, because conditions favourable for the development of such industries are now being created as a result of the rapid expansion of both hydel and thermal power production in the country. Certain electrothermic industries, such as calcium carbide and ferromanganese, which had been established in India in recent years, are now being expanded to meet the full requirements of the country. He further pointed out the initial difficulties encountered by the industries in using the available raw materials and indicated the extent of investigational work involved in the manufacture of these products in conformity with the Indian Standard Specification. Finally, Mr Naidu emphasized the importance of various other electrothermic industries including production of ferro-alloys, tungsten carbide, calcium phosphide, phosphorus and phosphoric acids, and discussed the principles of their manufacture as well as their main uses.

The audience very much appreciated the great care Mr Naidu had taken to make his talk interesting and entertaining.

The Chairman, in his speech, drew attention to the importance of electrothermic industries in general and calcium carbide in particular, because it could be used as a raw material for the manufacture of a large number of important industrial products.

At a subsequent meeting of the Committee, the following Officers were elected: Chairman, Dr N. K. Sen; Vice-Chairman, Mr N. B. Sen; Hon. Secretary, Dr A. B. Sen Gupta and Hon. Treasurer, Dr R. N. Chakravarti.

CHEMICAL SOCIETY LIBRARY

EASTER AND WHITSUN CLOSING

The Library of the Chemical Society closes at 1 p.m. on Thursday, 14 April and will reopen at 9.30 a.m. on Wednesday, 20 April.

The Library will also be closed on Monday and Tuesday, 6 and 7 June.

The Regulations of the Library, to which all Institute members have access, are printed on p. xi.

News and Notes

PRIZES AND AWARDS

Corday-Morgan Medal and Prize.—The Corday-Morgan Medal and Prize for 1958 has been awarded to Professor C. Kemball, *Fellow*, Professor of Physical and Inorganic Chemistry, Queen's University, Belfast, in consideration of his contributions to the study of heterogeneous catalytic reactions.

This Award, consisting of a Silver Medal and a monetary Prize of 200 Guineas, is made annually to the chemist of either sex and of British nationality who, in the judgment of the Council of The Chemical Society, has published during the year in question the most meritorious contribution to experimental chemistry, and who has not, at the date of publication, attained the age of thirty-six years.

Copies of the rules governing the Award may be obtained from the General Secretary of the Society. Applications or recommendations in respect of the Award for the year 1959 must be received not later than 31 December, 1960, and applications for the Award for 1960 are due before the end of 1961.

Swinburne Award.—The Plastics Institute's Swinburne Award, instituted in 1959 and consisting of a gold medal, a certificate and a sum of money, will now be an international award.

The award will be made to persons who shall have made an outstanding contribution to the science or technology of plastics engineering, or any science or technology in any field relating to plastics or plastics engineering.

EDUCATIONAL

Chemistry in Technical Colleges.—A residential course for teachers of chemistry in technical colleges has been arranged by a sub-committee of the Regional Advisory Committee for Applied Chemistry and Chemical Engineering and will be held at the Training College, Bognor Regis, from 22 to 24 April.

The programme will include lectures and discussions on the modern approach to the teaching of chemistry; petroleum as a source of industrial chemicals; current research into coal as a source of industrial chemicals; agricultural produce as a source of industrial chemicals; and the industrial training parts of advanced sandwich courses in applied chemistry. Further particulars may be obtained from the Regional Advisory Council for Technological Education, Tavistock House South, London, W.C.1.

Teaching Corrosion Science to Engineers.—A conference on this subject arranged by the Corrosion Group Education Panel of the Society of Chemical Industry will be held on 22 April at 14 Belgrave Square, S.W.1. Further particulars may be obtained from Mr W. D. Parker, Winn & Coales Ltd, Denso House, Chapel Road, S.E.27.

Government of Technical Colleges.—A booklet entitled *The Technical Colleges and their Government* has been published by the Federation of British Industries. This publication was prepared by a joint F.B.I.–Technical Colleges committee, under the auspices of the F.B.I. Education Committee; it gives from industry's viewpoint an appraisal of the government of technical colleges in the U.K. The position is reviewed in the light of industry's rapidly growing needs for trained technical and commercial staff and the consequent necessity for increased consultation between industry, commerce and the colleges. The first section of the booklet contains recommendations based on these considerations and on a sample survey of conditions prevailing in a number of colleges. Other sections deal with the finance of technical colleges in this country, the structure of technical education and the historical background to it.

This important statement serves to underline the Ministry of Education Circular 7/59, published in August, 1959, on *Governing Bodies for Major Establishments of Further Education* and Regulation 8 of the Further Education Regulations, 1959, which prescribes that 'major establishments of further education shall all have governing bodies which shall include substantial representation of industrial, commercial and other appropriate interests and, in the case of establishments providing a considerable number of courses requiring prior approval, representatives also of universities and professional bodies.'

Copies of the publication may be obtained, price 5s., from the Federation of British Industries, 21 Tothill Street, London, S.W.1.

MEETINGS AND CONFERENCES

Society for Analytical Chemistry.—At the 86th Annual General Meeting of the Society held in Birmingham on 2 March the following officers were elected: *President*, Mr R. C. Chirnside; *Past Presidents serving on the Council*, Drs J. H. Hamence, D. W. Kent-Jones, J. R. Nicholls and K. A. Williams; *Vice-Presidents*, Dr D. C. Garratt, Dr M. A. Pyke and Mr J. G. Sherratt; *Hon. Treasurer*, Dr A. J. Amos; *Hon. Secretary*, Dr R. E. Stuckey; *Hon. Assistant Secretaries*, Messrs L. Brearley and S. A. Price.

After the business meeting Professor A. C. Frazer gave the Sixth Bernard Dyer Memorial Lecture on 'Chemical Analysis and Medical Progress.' During his address Professor Frazer said that the full use of the latest developments in chemical analysis in medicine required more recruits from both chemical and biological fields. He continued: 'Chemists must acquire understanding of the biological issues, and biologists (including doctors) must know enough chemistry, to

work in close association. Such groups are altogether too few. There is need to reorganize the education of medical students in chemistry and biochemistry, and to provide opportunities for chemists, biologists and medical graduates to pursue courses planned to ensure closer integration.'

Mr Chirnside then presented the Bernard Dyer Memorial Medal.

Canadian Chemical Conference.—The 43rd Conference and Exhibition of the Chemical Institute of Canada will be held in Ottawa from 13 to 15 June. Among the subjects to be discussed will be how an interest in science can be stimulated in high-school students. Further particulars may be obtained from the Chemical Institute of Canada, 48 Rideau Street, Ottawa 2, Ontario.

National Society for Clean Air.—An 'open invitation' session is to be held during the Society's annual conference at Harrogate on 5–7 October, and contributions are invited. Details of the conditions under which papers will be accepted are available from the Society, Palace Chambers, Bridge Street, S.W.1.

Fertilizer Analysis.—The Society for Analytical Chemistry and the Fertilizer Society are organizing jointly a Symposium on Fertilizer Analysis to be held at Church House, Westminster, from 21 to 22 April. The proceedings of the symposium will be published by the Fertilizer Society. A registration fee of 20*s*. will be charged to each member. All enquiries should be addressed to the Secretary, The Fertilizer Society, 44 Russell Square, W.C.1.

Forthcoming International Conferences.—An addendum to list No. 26 has been prepared by the Overseas Liaison Group, D.S.I.R., Africa House, Kingsway, W.C.2, and covers the period April to July, 1960 (*see* also p. 143).

Gases in Metals.—A meeting on 'The Determination of Gases in Metals,' organized by the Society for Analytical Chemistry in conjunction with the Iron and Steel Institute and the Institute of Metals, will be held in the Convocation Hall, Church House, S.W.1, on 3 and 4 May. The arrangements for the meeting are in the hands of the Iron and Steel Institute, and further particulars may be obtained from the Secretary, 4 Grosvenor Gardens, S.W.1.

Gas Plant and Corrosion.—A joint symposium sponsored by the Institution of Gas Engineers, the Society of Chemical Industry Corrosion Group and the College of Advanced Technology, Birmingham, is being held from 22 to 23 September on 'The Protection of Gas Plant and Equipment from Corrosion.'

The symposium will take place at the College and will include papers on fundamentals of corrosion and protection; organic protective coatings; the protection of structural steel against corrosion; the corrosion of cast iron in the gas industry; principles and application of cathodic protection; protection of gas service pipes and fittings; corrosion and the gas consumer; and sprayed metal coatings in the gas industry.

The registration fee is two guineas for members of the sponsoring bodies, three guineas for others. Further information may be obtained from Mr A. S. Blower, Department of Chemistry, College of Advanced Technology, Suffolk Street, Birmingham 1.

Iron and Steel Institute.—The Annual General Meeting of the Iron and Steel Institute will take place on 3–5 May at the Royal Commonwealth Society, Caxton Hall, London. The meeting will include a symposium on 'Wide Strip Production' and the Members' Dinner will be held on 4 May.

The Iron and Steel Institute is also organizing a special meeting in Italy, including a joint meeting with the Associazione Italiana di Metallurgia.

Further details of both meetings may be obtained from the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1.

S.C.I. Liverpool Symposium.—A two-day symposium organized by the Liverpool Section and Chemical Engineering Group of the Society for Chemical Industry will take place in Liverpool on 22–23 September. The subject of the symposium will be the Manufacture and Use of Some Catalysts in the Petroleum and Petrochemical Industries and papers will be presented on petroleum desulphurization catalysts; silica-alumina cracking catalysts; ammonia reforming catalysts; and platinum reforming catalysts. Works visits are also being arranged.

Further details may be obtained from Mr J. H. Harwood, Peter Spence & Sons Ltd, Widnes, Lancs.

Medical Electronics.—The 3rd International Conference on Medical Electronics organized by the Electronics and Communications Section of the Institution of Electrical Engineers in association with the International Federation for Medical Electronics will take place at Olympia from 21 to 27 July.

All those interested should apply to the Conference Secretariat, The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Institute of Metal Finishing.—The Annual Conference of the Institute of Metal Finishing will take place at the Grand Hotel, Scarborough from 26 to 30 April. There will be five technical sessions, a reception and dance (by invitation of the Mayor and Corporation) and a Conference Dinner. Further details are obtainable from the Conference Secretary, Institute of Metal Finishing, 32 Great Ormond Street, London, W.C.1.

S.A.C. Microchemistry Group.—At the 16th Annual General Meeting of the Microchemistry Group of the Society for Analytical Chemistry on 19 February

Mr F. Holmes was re-elected Chairman. The following officers were also elected : *Vice-Chairman*, Mr. C. Whalley; *Hon. Secretary*, Mr D. W. Wilson; and *Hon. Treasurer*, Mr G. Ingram.

The Polarographic Society.—A meeting of the Polarographic Society was held at the Institute of Diseases of the Chest on 11 February. The subject of the meeting was 'The Determination of Oxygen in Biological Systems'; several papers were read, on 'Respiratory measurements with a vibrating unshielded platinum cathode and silver anode; ageing and linearity of response'; 'Difficulties in measuring the partial pressure of oxygen in tissue'; 'Measurement of partial pressure of oxygen in vivo'; 'Hersch cell'; 'The Polarograph for oxygen estimation in respiring biological systems'; 'New method for oxygen analysis'; and 'Measurement of partial pressure of oxygen in blood.' In addition there was a short contribution on 'The use of solid micro-electrodes in tissue.'

The 5th Annual General Meeting of the Society then took place and Mrs B. Lamb was re-elected Chairman of the Society.

Production Exhibition Conference.—The British Productivity Council is organizing a four-day Conference to be held in conjunction with the Production Exhibition to be staged at Olympia from 25 to 29 April.

The conference will be entitled 'Productivity—Men and Methods' and will consist of eight half-day sessions on computer and production control; fitting the job to the worker; works study and industrial engineering; variety reduction; quality control; communications in industry; training of supervisors; and organizing for cost reduction.

Tickets, 25s. each per session, and further information can be obtained from the British Productivity Council, 21 Tothill Street, London, S.W.1.

Soils, Fertilizers and Plants.—A symposium, organized by the Agriculture Group of the Society of Chemical Industry on 'Advances in the Chemical Analysis of Soils, Fertilizers and Plants' will be held in the Hoare Memorial Hall, Church House, Westminster, from 20–21 April.

The meeting has been arranged for the presentation and discussion of pre-printed papers of previously unpublished work. The papers will later be published in the *Journal of the Science of Food and Agriculture*.

The registration fee for the symposium is 50s. (30s. for members of the S.C.I.) and all enquiries should be addressed to Mr P. W. Arnold, Agriculture Group, S.C.I., Rothamsted Experimental Station, Harpenden.

S.C.I. Tour of Western Germany.—The Fine Chemicals Group of the Society of Chemical Industry is arranging for a party of members to tour certain centres of chemical industry in the Cologne and Frankfurt areas in May this year.

All enquiries should be addressed to Dr E. B. Knott, Kodak Ltd, Wealdstone, Harrow, Middx.

RESEARCH HIGHLIGHTS OF THE N.B.S.

Although inevitably there will be many who regard the Annual Report of the National Bureau of Standards only as a brief catalogue of the Bureau's activities, it serves a valuable purpose for all readers in summarizing the wide range of activities being undertaken in a programme now costing 35 million dollars. In a sentence, the Bureau describes its mission as the provision of a 'central basis for a complete, consistent system of physical measurement of national scope adequate for the expanding national activity in scientific research.' In the Report for 1959, it is claimed that special attention has been given to improving standards and measurement techniques in high temperature, pressure, atomic standards of length, and atomic standards of frequency. Advances are claimed to have been made in studies of molecular structure of alloys, in the determination of microquantities of tritium and in the characterization of the atmosphere in regions associated with satellite exploration. Further details are given of these activities and many others under sections entitled electricity and electronics, optics and metrology, heat, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, data-processing sysstms, cryogenic engineering, radio propagation, radio standards, weights and measures and basic instrumentation. Among items of special interest mentioned in the chemistry section are: analysis of tritium-labelled compounds, acid strength in benzene, determination of phosphate, silicate and arsenate, separation of metallic elements in high-temperature alloys, air pollution, molten salt studies, abrasive jet, international comparison of techniques for determining purity, spectrometric analysis by X-rays and nuclear magnetic resonance studies. There can be few readers of this report who will not find its cost of 55 cents justified if only as a check that they are aware of the reports and published papers, emanating from the Bureau, in their own specialized and related fields of activity. (U.S. Government Printing Office, Washington 25, price 55 cents.)

F. HARTLEY

Appointment of Deputy Science Officer.—The United States Department of State has announced the appointment of Dr John B. Bateman as deputy science officer in London under its Science Officer Programme (see *J.*, 1959, 60).

Commonwealth Technical Training Week.—A Commonwealth Technical Training Week will be held in the United Kingdom from 29 May to 4 June, 1961. It is hoped that it will also be possible to hold the Week

in other parts of the Commonwealth and that, as far as possible, the same dates will be chosen.

The object of the training week is to stimulate awareness of the responsibility of the community towards young people entering employment, and to stress the importance of schemes of induction and training. A booklet is in preparation which will list the activities that might be arranged during the week. Civic functions, careers exhibitions and open days in firms and educational establishments are a few possibilities.

The City and Guilds of London Institute is administratively responsible for the central organization of the Commonwealth Technical Training Week. In this country, however, the direct organization will be in the hands of local authorities, under the general supervision of a United Kingdom Committee.

Inquiry into the Clean Air Act.—A nation-wide inquiry into the working of the Clean Air Act of 1956 is being conducted by the National Society for Clean Air. A questionnaire is being sent to the 1,700 local authorities in England, Wales and Scotland who are responsible for administering the Act to ascertain how well, or otherwise, the Act is succeeding.

The Act, which followed the proposals of the Beaver Committee on Air Pollution, introduced so many new methods and principles for the prevention of smoke that it has become desirable to learn how effective it is proving to be in practice, what weaknesses or difficulties may have emerged, and whether any changes should be sought, either in the Act itself or in any of the regulations that have been made under it.

The questionnaire is in twelve main sections, each of which includes queries on points of detail, ranging from the number of cases of dark smoke emission brought to court, to the state of public opinion in proposed smoke control areas. One of the needs, stressed by the Beaver Committee and allowed for in the Act, is in the field of education and publicity, and the questionnaire asks what is being done to make sure that the need for clean air is understood.

The replies to the questionnaire, after being analysed, will be the subject of reports that are to be presented for discussion at the annual conference of the Society at Harrogate in October. It is expected that the information obtained and the inferences that may be drawn from it will be of considerable importance to all local authorities and to the central government itself.

Further details may be obtained from the National Society for Clean Air, Palace Chambers, Bridge Street, London, S.W.1.

Messel Medal.—The Medal, the senior award of the Society of Chemical Industry, will be presented to the Rt Hon. The Viscount Chandos, D.S.O., M.C., medallist for 1960, during the Society's Annual Meeting in Bristol on 6 July. Previous recipients include Sir Henry Tizard and Sir Alexander Fleck.

National Lending Library.—The *LLU News* announce that some buildings in Yorkshire are now being adapted to house the National Lending Library and should be ready for occupation in March 1961. They will hold about one million volumes.

Meanwhile the D.S.I.R. Lending Library Unit at 20 Chester Terrace (Tel. HUNter 8361) would be interested to hear of any surplus scientific literature available for purchase or presentation.

A book collection has also been started recently, and further particulars can be obtained from the above address.

Visitors to the U.K.—Among visitors who will be in this country during May are: K. Folkers, of Merck, Sharp & Dohme, New Jersey (7–15); E. Høff-Jorgensen, University of Copenhagen, and Professor F. Lynen, Max-Planck-Institut, Munich (9–15); Professor O. Wiss and O. Isler, Hoffman-La Roche & Co., Basle, Professor F. L. Crane, University of Texas, L. Wattenberg, University of Minnesota, Professor S. Laland, University of Oslo, Professor D. E. Green, University of Wisconsin, A. F. Brodie, Harvard Medical School, Boston, Professor C. Martius, Eidgenössische Technische Hochschule, Zürich, Professor A. L. Lehninger, Johns Hopkins School of Medicine, Baltimore, Professor E. C. Slater, University of Amsterdam, and R. Lester, University of Wisconsin (10–15); Professor H. Rudney, Western Reserve University, Cleveland, Ohio (11–15); Professor R. E. Olson, University of Pittsburg (11–18); and Professor A. H. Ennor, Australian National University (19–26).

LOCAL SECTIONS DIARY

Sections are glad to welcome members of other Sections to their meetings and social functions, except when numbers are restricted, as for works visits. Those wishing to attend meetings outside their own area are advised to write to the Hon. Secretary of the Section concerned, as the Institute cannot accept responsibility for any alterations or cancellations. All times are p.m. except where otherwise stated.

(T) **Bangor.** 21 May. Summer Outing.

(B) **Belfast.** 2 May. 7.15. Queen's University. Annual General Meeting.

(O) **Birkenhead.** 28 April. 7. Flash Photolysis and the Study of Fast Reactions. Professor G. Porter. Technical College, Borough Road.

(E) **Cardiff.** 6 May. 6. Annual General Meeting. Royal Hotel.

(T) **Connah's Quay.** 27 April. 7.30. Intermetallic Chemistry. Professor W. Hume-Rothery. Flintshire Technical College.

(F) **Cork.** 29 April. 8. Some Recent Developments in Explosives. Dr J. Craik. University College.

(F) **Dublin.** 27 April. 5.30. Dr J. Clark. (See Cork). University College.

(M) **Hull.** 28 April. 6.45. A.G.M. followed by Lecture: Chemical Background to Colour Photography. Dr G. I. P. Levenson. The University.

(P) **London.** 25 April. 6.30. Ladies' Evening: Laundering Modern Fabrics. J. Leicester and F. R. Hill. Royal Institution, Albemarle Street, W.1.

(S) **Newcastle-on-Tyne.** 4 May. 6. A.G.M. followed by Lecture: Petroleum—Petrochemical Industry. E. LeQ. Herbert. Chemistry Department, King's College.

(W) **Plymouth.** 28–30 May. Summer Joint Meeting with S.A.C. Dr L. H. N. Cooper *et al.* Technical College.

(R) **Poole.** 26 April. 7.30. Lubrication. J. E. James. Generating Station. Joint, Poole Technical Group.
—— 14 May. 2.30. Annual General Meeting.

(U) **Sheffield.** 12 May. 7.30. A.G.M. followed by Film Show. Chemistry Lecture Theatre, Brookhill.

(V) **Swansea.** 29 April. 7.30. Annual General Meeting. Mackworth Hotel.

Obituary

William Monteith. *B.* 5.10.1893. *Ed.* Hutcheson's Grammar School, Glasgow; University of Glasgow, 1912–15, 1916–17 (interrupted by service in H.M. Forces). B.Sc. He joined Nobel's Explosives Co. Ltd (now Imperial Chemical Industries Ltd) in 1917, where he remained for the whole of his working life. He became deputy chemist-in-charge of the analytical laboratories in 1920, and a member of that section of the Technical Department concerned with propellants and nitrocellulose in 1925. He was appointed assistant works manager of the Powfoot factory in 1940, and three years later manager of the propulsive explosives department at Ardeer. At the time of his retirement in 1956 he was chief superintendent of the department. 'He was a quiet man who held calm convictions that were not easily shaken.' (*A.* 1917, *F.* 1947.) *D.* 11.9.59.

Harry William Edward Osborn. *B.* 11.4.01. *Ed.* Regent Street Polytechnic, 1917-20; Sir John Cass Technical Institute, 1920-22; Northern Polytechnic Institute, 1924-27. He commenced his career in 1917 as a pupil-assistant to Mr W. H. Simmons, analyst and consulting chemist. Thereafter he became successively chemist, Loders & Nucoline Ltd, 1919; analytical and electrochemist, Hart Accumulator Co. Ltd, 1925; assistant works manager, Alton Battery Co. Ltd, 1929; assistant manager and research chemist, International Electrolytic Plant Co. Ltd, 1936; chemist and engineer, Bocnal Tobacco Co. Ltd, 1940; chemist in charge of development and research, John Dale Ltd, 1942. Later he became works manager of the Amalgamated Dental Co. Ltd, and at the time of his death was a director of Amalgamated Dental Prosthetic Products Ltd. (*A.* 1927, *F.* 1944.) *D.* 26.11.59.

Frederick James William Popham. *B.* 7.11.1886. *Ed.* City and Guilds of London Technical College, 1902–05. His first appointment was in the laboratory of the Gas Light & Coke Co. in 1905. Thereafter he became works manager, Major & Co. Ltd, Hull, 1909; process chemist, Wetcarbonizing Ltd, Dumfries, 1913; works chemist, Wm Butler & Co. (Bristol) Ltd, 1916, being later promoted to works manager. He left in 1928 and was for a short time engaged by L. H. Process Ltd before being appointed officer in charge, Wood Preservation Section, Forest Research Institute, Dehra Dun, India, in 1929. Some years later he joined the British Rubber Producers' Research Association as a research chemist and remained there until his retirement in 1957. (*A.* 1918, *F.* 1924.) *D.* 17.9.59.

Rames Chandra Ray. *B.* 25.1.1890. *Ed.* Presidency College, Calcutta, 1905-11. M.Sc. He joined the Indian Institute of Science, Bangalore, in 1912, as a research worker under Professor M. W. Travers, F.R.S., where he remained until 1915, when he was appointed professor of chemistry in Patna College, and an examiner of the University of Patna in 1918. He proceeded to England in 1920 to undertake research in the laboratory of Professor F. G. Donnan, F.R.S., at University College, London, resulting in the award of the degree of D.Sc. in 1923. He returned to India and in 1940 was appointed head of the department of chemistry in Patna Science College as well as chemical adviser to the Government of Bihar. After his retirement in 1946 he maintained an active interest in the research work at Patna Science College. He served as president of the chemistry section of the Indian Science Congress held in Delhi in 1944. He was the author, or co-author, of papers in the scientific press. (*F.* 1926.) *D.* 3.12.59.

George Frederick Robertshaw. *B.* 6.10.1887. *Ed.* Manchester College of Technology, 1903–08. He joined Levinstein Ltd, Blackley, as a chemist in 1903 and later became head and chief chemist of the oil department. He left in 1924 to join James Malcolm & Co. (Glasgow) Ltd, where he remained until his retirement in 1958, when he was managing director of the company. He was co-author of *Sulphated Oils and Allied Products: Their Chemistry and Analysis* (1939), and of a number of papers. He represented the Society of Leather Trades' Chemists at meetings of the International Commission for the Study of Oils and Fats and served on appropriate committees of the British Standards Institution. For many years he took an active part in the Boy Scout Movement. (*A.* 1919, *F.* 1944.) *D.* 24.10.59.

Andrew Smith. *B.* 2.4.1876. *Ed.* University of Glasgow, 1895–99. In 1899, he joined a small chemical works, which has since ceased to exist. He was appointed as chemist to Leech, Neal & Co. Ltd, Derby, in 1902, where he remained until his retirement. He had been managing director since 1912. (*F.* 1928.) *D.* 8.11.59.

James Herbert Francis Smith. *B.* 3.10.12. *Ed.* Regent Street Polytechnic, London, 1934–36; Sir John Cass Technical Institute, 1934–36. M.Sc. He was appointed an assistant in the laboratories of the War Department Chemist, Royal Arsenal, Woolwich, in 1933, and was transferred the following year to the Government Laboratory. He left in 1937 to take a post as chemist in charge of the laboratory of Max Factor & Co. He joined the Factory Department of the Home Office (a department which was later transferred to the Ministry of Labour and National Service) in 1938 and was promoted to H.M. Inspector of Factories, Engineering and Chemical Branch, in 1943. A few years before his death he became an assistant technical officer of the Fire Officers' Committee. (*A.* 1934, *F.* 1946.) *D.* July, 1959.

eter Wright Tainsh. *B.* 14.4.1881. *Ed.* Greenock cademy; Royal Technical College, Glasgow, 1899-902. He joined Nobel's Explosives Co. Ltd (now mperial Chemical Industries Ltd) as a chemist in 1902, maining until the end of 1913, when he left on his ppointment as chief chemist to Lever Bros Ltd (now nilever Ltd). After the outbreak of the First World Var he was appointed Supervisor of Factories, Pro-ellants Branch, Ministry of Supply, until the end of 918. He was awarded the O.B.E. for his valuable rvices. He returned to his previous position in 1919 here he remained until his retirement in 1946. The niversity of Liverpool honoured him in 1930 by nferring upon him the honorary degree of M.Sc. for is great service to industrial chemistry and for having romoted much good will between the University and erseyside industry. He was deeply interested in usic and art, and was a keen and efficient gardener, articularly in rock gardening. "Tainsh was a very apable administrator, very tolerant, and always ready see the other side of the question." (*A.* 1902, 1927; Council 1928-31.) *D.* 5.11.59.

eoffrey Edmond Waller. *B.* 2.11.24. *Ed.* Batter-a Polytechnic, 1947–50; Woolwich Polytechnic 1950–1. .Sc. His first appointment was as an analytical emist at Bayer Products Ltd. He later joined the aff of Ward, Blenkinsop & Co. Ltd, and was seconded s chief analyst to Harker Stag Ltd. (*A.* 1951). . 7.12.58.

ames Stoddart Watson. *B.* 10.5.19. *Ed.* Cumnock cademy; University of Glasgow, 1937–41. B.Sc., h.D. After serving in the R.A.O.C., attaining the nk of captain, he returned to the University of lasgow as an assistant in chemistry, and shortly after ined the Chemistry Division of the National Research ouncil, Ottawa. He then spent a few years as a search chemist in the General Research Organization Olin Industries Inc., New Haven, Conn., U.S.A., efore returning to the National Research Council, ttawa, as an associate research officer in the Division Applied Chemistry, a post which he held at the time his death. (*A.* 1941.) D. 29.7.59.

CORRESPONDENCE

EDUCATION OF CHEMISTS

SIR,—Professor Cottrell's address (*J.*, 57) was both mely and stimulating; it will initiate many discussions nd I would like to contribute the following points rough your columns.

Contrary to Professor Cottrell, I should not wish to e any reduction in the amount of practical work, but I ke the methodical division of the problem into manipu-tive and research experiments. Rather than the udent only becoming proficient in particular operations by repeated practice in analytical spots and the like, he can be *taught* quickly manipulative operations covering a wide field. Consequently appreciable time would become available for the carrying out of practical research experiments. In this phase of the work it would be necessary for the student to obtain for himself an adequate background of theoretical knowledge for each investigation. Confidence in combining theoretical studies with the initiation of experiments is the hallmark of a good chemist, and the main aim of the science degree course should be the creation of this confidence.

Professor Cottrell affirms that about 74 per cent of graduates are following careers outside the University. This in turn creates the problem of how the essential contact is to be made between the student and the members of the profession he is entering. If eventually he is to join a government or industrial research organization it is important that during his formal education he should be in contact with persons who have been successful in this type of work. The answer to this may lie in vacational employment but the present haphazard arrangements would have to be made more systematic. The student could be recommended to laboratories where he would come under the influence of established research workers. During his course he should work in laboratories of different types, for example, those in private industry, in government establishments or in research associations. By this method he may learn what conditions are necessary for the promotion of good research and where they can be found.

M. I. GILLIBRAND

'Erlesmere,' Rutland Road,
Ellesmere Park, Eccles, Lancs.

THE REGISTER

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(C) CAVELL, Alexander Corry, M.A., B.SC.(OXON.)

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(E) WOOD, James, A.H.-W.C.

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(C) GRAHAM, Robert Leslie, DIP.TECH. (BIRM.)
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(SS) KENYON, John Henry
(Q) KIRBY, John Alexander, B.SC. (ST. AND.)
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(S) McGHEE, Brian
(C) MELLOWS, Vincent Edward, DIP.TECH. (BIRM.)
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(E) MORRIS, Ivor Graham, B.SC. (WALES)
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(U) NIXON, Leslie Arthur
(O) PUGH, Gladys Yvonne
(S) RAEBURN, Eric
(S) RAPER, Eric Salvin
(SS) RENNISON, Peter Arthur
(L) ROBERTS, Brian
(O) ROBERTS, Charles Waid
(P) ROCHESTER, Colin Herbert, B.SC. (LOND.)
(O) SHELTON, Alan
(E) SMITH, Harry, B.SC. (LOND.)
(U) TAYLOR, Malcolm Stuart
(L) THORPE, Donald
(Q) TURNER, Brian
(P) WARWICKER, Laurence Albert
(SS) WEBSTER, Norman William Fletcher
(J) WHITE, Hugh Briggs, A.H.-W.C.
(O) WILLIAMS, Brian

DEATHS

Fellows

(R) BLOCKEY, John Reginald, M.SC. (LEEDS). Died 27 February, 1960, aged 73. *F.* 1944.
(D) GARNER, William Edward, C.B.E., M.SC. (LOND.), D.SC. (BIRM.), F.R.S. Died 4 March, 1960, aged 70. *A.* 1919, *F.* 1946.
(X) HANNAY, James Ramsay. Died 5 March, 1960, aged 86. *F.* 1919.
(P) MOORE, WILLIAM. Died 19 November, 1959, aged 89. *A.* 1897. *F.* 1902.
(P) O'SHAUGHNESSY, Bernard. Died 27 January, 1960, aged 83. *A.* 1905, *F.* 1909.
(A) ROBB, Marshall Jeffreys, B.SC. (ABERD.). Died February, 1960, aged 71. *A.* 1912, *F.* 1915.
SCHWARZ, Theodor. Died 19 February, 1960, aged 74. *A.* 1910, *F.* 1919.
(P) TAYLOR, George, O.B.E. Died 28 February, 1960, aged 79. *F.* 1917.

Associates

(R) CHANDLER, Romily David Thomas Ernest. Died 15 January, 1960, aged 46. *A.* 1947.
(N) THORNTON, Eric, B.SC. (LEEDS). Died 4 March, 1960, aged 43. *A.* 1953.

Graduate Member

(P) BRERETON, Donald. Died 17 December, 1959, aged 25.